**A systematic review of technology in English as a second language: Focus on primary and secondary education.**

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**Abstract**

After explaining why consideration of the use of technology in second language (L2) teaching in the primary and secondary sectors is necessary, this systematic review presents a *keyword map* of 117 papers that have researched technology in L2 learning since 1990. It reveals that research effort has increased, in these educational phases, in line with technological developments and that there have been important differences in the adoption of applications between the primary and secondary sectors. We then provide an *in-depth review* of 47 post-2000 studies which investigate the efficacy of technology in the teaching of L2 English. We ask what technology has been used in the new century and why, what evidence there is that technology facilitates language learning, and what other insights can be drawn from the research in this field. The evidence that technology has a direct beneficial impact on linguistic outcomes is slight and inconclusive, but it may impact indirectly and positively by changing learner attitudes and learning behaviours and may promote collaboration. However, the research surveyed does not differentiate these positive impacts by group differences (e.g. gender). On the whole the research reviewed lacked the quality that would reassure practitioners and policy-makers that technological investment is warranted. We argue that future research needs to provide a tighter link between technological applications, Second Language Acquisition (SLA) theory, and learning outcomes.

**1. Introduction**

Between 1998 and 2004 the UK’s education department injected £1.8 billion into schools to boost the use of computers and ICT (Ofsted, 2002; for acronyms and technical terms see Appendix A). Singapore launched its *Masterplan for IT in Education* in 1997; by 2002 all schools were equipped with computers and internet access, and second and third *Masterplans* have been implemented (Ministry of Education, Singapore, 2008). In the USA, following the *Telecommunications Act 1996*, in the period 1998-2001, over $1.7 billion dollars per year was invested in ICT in schools through subsidies for the purchase of Internet technology (Goolsbee and Guryan, 2006).

More recently, the Spanish government launched the *Escuela 2.0* initiative (Presidencia del Gobierno, 2009), aimed at providing over 14,000 classrooms in both the primary and secondary sector with iwbs, wireless internet, and PCs for students and teachers. In Italy the *Piano e-Government 2012* (Governo Italiano, 2009) aims to provide every school with broadband and at least three ICT suites equipped with iwbs and PCs. According to UNESCO (2009), China aims to connect 90 per cent of primary and secondary schools to the Internet by 2010.

We predict with some confidence that language learning classrooms have been and will be expected to participate in this switch to higher levels of technology use. It is therefore crucial to review research on digital technology in language teaching, or Computer-Assisted Language Learning , including mobile technologies (henceforth CALL; Levy and Hubbard, 2006), in the primary and secondary sectors, in order to inform teachers, policy makers and materials designers. Previous CALL reviews have generally been of two kinds. Firstly, some reviews have identified various historical phases in CALL pedagogy (Warschauer, 1996; Delcloque, 2000; Chapelle, 2001; Bax, 2003; Jung, 2005). Space does not allow us to review these phases, but note that some authors feel CALL has been technology-driven rather than serving pedagogical needs (Delcloque, 2000). From a pedagogical perspective, some argue that CALL has never been communicative in the sense intended by most theorists (Bax, 2003), and others that there is an unfortunate top-down tendency, whereby CALL in higher education percolates down to younger learners (Jung, 2005), without reflection on the younger group’s different needs.

Secondly, there have been reviews of CALL providing summaries and syntheses of research using traditional (narrative) methods (Levy, 2009), or attempts at more comprehensive methods (Stockwell, 2007) but restricted to CALL-related journals[[1]](#endnote-1) and without differentiating various levels of education. Regarding both these types of reviews, note that, already in 1987, Pederson advocated narrowly targeted studies focusing on differential effects of attributes of the technologies, controlling for other features, and ensuring an investigation not only of the medium itself, but also of the way it is manipulated in the learning context. Levy (1997) agreed, but emphasized that isolating a key variable should not sacrifice ecological validity; similarly, Chapelle (2001) proposed that any product-oriented investigation be complemented by process-oriented observation. In other words, we should be asking not only ‘Is the technology effective?’ but also ‘Why is it effective, and how does this contribute to a theory of language learning or of education more generally?’ Stockwell (2007: 115), reviewing studies between 2001 and 2005, concluded that “there still remains an element of failure to stipulate why a given technology was used in achieving learning objectives”, and that there is a need for research investigating how technologies are used. Lastly, many reviewers (e.g. Felix, 2005; Hubbard, 2005) comment on the poor quality of research and reporting in CALL.

We have attempted to take account of these issues into the review questions and methodology of the current systematic review.

**2. General aim of the review**

This systematic review aims to achieve the broadest possible coverage of empirical research evidence for the use and effectiveness of CALL in the primary and secondary phases of L2 education. To achieve this we followed the EPPI reviewing system (EPPI-Centre, March 2007) which proposes first a *keyword map* (overview) using keywords to categorize studies, then an *in-depth review* of a subset of studies selected according to inclusion criteria.

For those not familiar with systematic reviewing, it is important to note five features differentiating it from more traditional narrative reviewing. A systematic review:

1. is transparent in how it is carried out, from the moment of conception to the final conclusions; and an initial protocol sets out how the review is to be conducted;
2. demands that inclusion of studies is based on exhaustive and reliable searching;
3. aims to reduce reviewer bias as much as possible;
4. attempts to produce syntheses containing clear messages about the reliability of the evidence reviewed;
5. attempts to ensure that the research is relevant and accessible to end-users.

**3. Review questions**

The overarching question for the initial *keyword map* of this review was:

What empirical research has been undertaken on the use of CALL technologies in language learning and teaching with learners in primary and secondary schools between 1991 and 2010?

We have provided above a justification for focusing on these phases of language learning. We justify limiting our search to post-1990 on grounds of technological advancement – what Jung (2005: 10) calls ‘the online/offline divide’.

The questions for the *in-depth review* were:

1. What technologies are reported as being used with English language learners in the first decade of the 21st century, and why?
2. What evidence is there that technology facilitates the acquisition of linguistic knowledge and/or the development of language skills?
3. What insights, other than linguistic, are revealed by a review of research reports?

We justify our narrowing of focus to post-2000 research on the basis of advancements in technology and its use in educational contexts; and we justify focusing exclusively on English as the target language because of its role as the language most studied across the world in primary and secondary contexts.

**4. Method**

Once the general aims of the review and review questions were confirmed, we established a review protocol comprising the search strategy, the inclusion/exclusion criteria, the mapping procedure, the in-depth review procedure, and the synthesizing procedure.

**4.1 Search strategy**

Databases used for electronic searching were: for education, *Education Resources Information Center;* for linguistics*, Language and Linguistics Behavior Abstracts;* for psychology, *PsycINFO;* for computer science, *INSPEC.*

Different search strategies were tested, including free-text search and thesaurus. To ensure reliability, the search strategies were refined by inspecting the abstracts of retrieved articles and adding/deleting search terms for optimum precision and recall (final search strategy is in Appendix B). Selective manual searching was additionally carried out, to increase the reliability of the electronic searching. The journals manually searched were: *CALL Journal, ReCALL, Language Learning & Technology,* and *CALICO Journal*.

**4.2 Inclusion/exclusion criteria**

On completing the search, we identified from the abstracts (and sometimes from the full reports) the studies to be included in the keyword map, according to these criteria:

1. They reported on the use of *CALL* (broadly conceived) *...*
2. ... in *foreign* or *second language learning ...*
3. ... with *school age* (primary and secondary) *learners.*
4. They focused on *learners.*
5. They reported on *empirical studies* carried out by the author(s)
6. ... which focused on the *effects of interventions on the acquisition of linguistic knowledge and skills*.
7. They studies were *reported between 1991 and 2010*
8. They were *published in peer-reviewed journals or in doctoral dissertations*
9. … *in English.*

Studies were *excluded* if they:

1. Focused on *corpus* technology, e.g. concordancers
2. Focused on *testing*
3. Focused on the teaching of *classics* (Latin and Ancient Greek).
4. Focused on *teachers* rather than learners

This yielded 117 studies for inclusion in the systematic keyword map. For the in-depth review we applied additional criteria. Studies were only included:

1. if they reported *on the effect* of the use of technology ...
2. *...* on *specific language skills ...*
3. ... of learners of *English as a Foreign Language (EFL)* or *English as a Second Language (ESL)...*
4. …and were *reported between 2001 and 2010.*

The application of these additional criteria yielded a total of 47 studies for the in-depth review.

**4.3 In-depth review: characterizing studies**

At least two reviewers independently read each paper in depth, using a grid of questions. They then met to compare answers and resolve any differences. It is particularly important in a systematic review to resolve differences in the quality assurance evaluations (High, Medium, or Low) regarding each study’s contribution to the in-depth review questions:

1. Relevance of the focus of the study;
2. Appropriateness of the study’s research design for addressing the review questions;
3. Trustworthiness of the study’s overall methodology;
4. Contribution of the study (as a result of 1-3) to the review questions.

**5. Review findings 1: The *overview* or *keyword map***

117 studies met the keyword map criteria. Keywording and mapping these studies revealed (Appendix D):

1. There was a significant increase in the number of studies conducted over the period 1991 to 2010 (Table 1).
2. More studies were conducted in the US (26%) than elsewhere.
3. The most popular technologies were multimedia (22%), cmc technologies (22%) and the internet (15%). Of the cmc technologies, e-mail was the most popular (12%; Table 4).
4. There was some interest in the use of text reconstruction, an early CALL technology, and in early general purpose technologies such as multimedia. Interest in the use of the internet increased; there are no studies focusing on the internet before 1995. Similarly, there are no studies focusing on chat and discussion forums before 2000, and no studies focusing on web 2.0 technologies before 2005 (Table 4).
5. More studies were conducted with secondary school students (60%) than with primary school students (40%).
6. English was the target language in 77% of the studies. European languages other than English were the next most popular target (24%).
7. The largest number of studies focused on vocabulary (24%) and writing (24%). Next came reading (22%), then grammar (7%). Many fewer studies focused on speaking (11%), listening (10%) and pronunciation (3%) (Table 1).
8. Technology for vocabulary teaching was equally investigated with primary and secondary students. Studies of technology in reading activities more frequently involved primary students than secondary students. Studies of technology in grammar and writing activities more frequently involved secondary students than primary students (Table 1).
9. Word processors, the internet, cmc, and web 2.0 were more frequently studied with secondary students than with primary students. Multimedia was more frequently investigated with primary students than with secondary students.
10. Multimedia studies are particularly associated with learning and teaching vocabulary. Word processors are associated with writing studies, as are cmc and web 2.0 technologies.
11. Regarding research methodology, most studies employed mixed methods (44%), and slightly more studies employed qualitative methods (31%) than quantitative methods (23%).[[2]](#endnote-2)
12. A wide variety of sample sizes were used, ranging from under 10 participants to over 200. The most popular sample size was 21-30 participants (14%).
13. Most studies did not indicate whether the participants were male or female (52%). In the majority of the remaining studies the sample was described as mixed (39%).

That 71 of the studies included in the map did not indicate the sex/gender of the participants, was an interesting finding given the evidence that boys and girls are attracted to different aspects of ICT and appreciate different educational applications of technology, boys being more interested in technical aspects and problem solving activities, and girls being more interested in creative aspects and social activities (Volman, van Eck, Heemskerk and Kuiper, 2005).

Especially interesting for our review is the finding that, although more studies were carried out in the secondary sector than the primary sector, the difference was not as large as might be expected, given earlier observations of the top-down effect from higher education (Jung, 2005).

The comparative lack of interest in grammar differed from Stockwell’s (2007) review, a difference probably resulting from his inclusion of research in higher education.

The differences in the match between language skills and school phase may be attributed to: (1) vocabulary and receptive language skills may be more privileged in primary education; (2) primary students are typically less able to type well and hence less able to use word processing facilities.

Note, however, that as well as focusing on linguistic knowledge and skills, these studies reported on a whole range of other outcomes: intercultural competence, narrative comprehension, stance taking, phonological awareness, critical thinking, inter-subjectivity, deep vs. surface learning, and knowledge construction.

Perhaps the greatest difficulty we encountered in keywording the map was identifying from abstracts and introductions precisely what technology was being used, and we often had to consult the whole paper for this information.

Having provided an overview of CALL in the primary and secondary phases between 1991 and 2010 (see Appendix D for a full *keyword map*), we now turn to the in-depth review.

**6. Review findings 2: The *in-depth review*.**

In the period 2001-2010 we identified 70 studies relating to the teaching of EFL or ESL in the primary and secondary phases. Of these, 23 were not specifically concerned with the acquisition of linguistic knowledge or skills and were therefore eliminated from the in-depth review, leaving 47 studies (Table 2). Within this decade, there was a general pattern of increase from 2008 and also a considerable number of studies in Taiwan, China and Hong Kong (n=21), with the US maintaining a strong presence (n = 7). In comparison, European countries contributed only 6 studies, a surprisingly low figure given the financial investment identified in our introduction.

There were 19 studies of primary phase learners and 28 of secondary phase learners. Again, few studies indicated sex/gender of participants (n=20). In the majority (n =22) of the remaining studies gender was indicated as mixed and not used as an independent variable.

Most of the 47 studies investigated the teaching of vocabulary (n = 15), reading (n = 17) or writing (n = 17). There was much less interest in grammar (n = 3), speaking (n = 9), listening (n = 8), and pronunciation (n = 3). Importantly, Table 3 shows that cmc and chat feature much more in the secondary sector than in the primary sector.

**6.1 Review question 1: What technologies for English language learning and why?**

The reviewers attempted to determine from each research report when the study was carried out; why it was carried out then; and why it was carried out with that particular population. We argue that unless CALL studies are contextualized in this way, it is difficult to discern a relationship between use of technology and the pedagogical need for it. There might also be a considerable time-lapse between data collection and publication, with obvious implications for any conclusions.

To take writing research as an example, of the 17 studies reviewed, only nine provided the date when the research was carried out. In Zhang, Gao, Ring and Zhang (2007), the authors state that there is a dearth of research regarding online discussion in ESL in China at an unspecified time and that, in high schools, technology is in place but is not used, primarily because ESL instruction in China is textbook- and test-driven. Somewhat more helpful are Lund and Rasmussen (2008), who report that the Norwegian government introduced knowledge promotion reform in 2006/2007 and that this, combined with an increase in digital and networked cultural tools becoming available, led to their study of wikis for improving writing. As motivation for their study, Lin and Wu (2010) mention the falling cost of laptops, one computer per child initiatives and the inception of netbooks and Suh et al. (2010) note the increasing popularity of gaming as a medium for socialization and potential educational benefits including engagement, motivation, critical thinking, problem solving and experiential learning. Other reasons for carrying out the research were often very specific to a particular context. In studies of writing these include:

1. The Taiwan Ministry of Education promotes computer use in English classrooms; EFL teachers encounter difficulties in introducing storytelling in Taiwan; teachers have problems in helping students understand cultural aspects of language (Tsou, Wang and Tzeng, 2006);
2. Technology may provide a bridge across age and cultural differences (Peng, Fitzgerald and Park, 2006), (a study about collaboration between young-adult technology students and children);
3. Quebec has a New Technologies Programme. Students need to be prepared to engage in ‘new literacies’ but research on high school use of ICTs for writing is scant (Parks, Huot, Hamers and Lemonnier 2005, p. 234);
4. Despite innovative moves in writing instruction in some Hong Kong schools, Hong Kong teachers focus on form rather than content; students usually only have to write 150 words and rarely collaborate (Mak and Coniam, 2008);
5. In Singapore students need competence in expository writing to enter university, where English is the medium of instruction. Singaporean teachers and students need to look at grammar and functions in writing. An earlier project reported a lack of argumentation skills (Chandrasegarand and Kong, 2006);

These statements reveal that the impetus driving the research is often policy rather than education theory. This is not to imply that policy-driven research should be shunned, but one might expect a stronger link to theories of L2 writing. This pattern repeats for the other language skills: often the impetus for a study, although pedagogic, is closely linked to very local concerns. For example, Coniam and Wong (2004) imply that they investigated the use of internet relay chat with grade 3 to 10 Hong Kong learners ranging because these students tended to make errors in the use of finite verbs in main clauses. Johns, Hsingchin and Lixun (2008) similarly imply that the reason for adopting, with Taiwanese secondary students, a technology based on gap-fill, putting sentences in the right order, and concordance based exercises was that the students normally receive a limited diet of EFL instruction aimed almost entirely at passing the university entrance exam.

**6.2 Review question 2: Impact of CALL**

We now review the evidence for whether technology facilitates acquisition of linguistic knowledge and the development of language skills. Note that we discuss in detail only those studies rated as making a ‘medium’ or’ high’ contribution to this review question (see Appendix E).

**6.2.1 Evidence from vocabulary studies**

One problem we encountered was the considerable variety in outcome measures. Whereas one might have expected these to be (as in non-CALL vocabulary acquisition literature) vocabulary breadth or depth, receptive or productive vocabulary growth, there was instead an interest in certainty of vocabulary knowledge (Kim and Gilman, 2008), the production of correct ‘index cards’ (Nakata, 2008), general vocabulary gains with no indication of whether this was receptive or productive (e.g. Kim and Gilman, 2008; Chen and Li, 2010), the Peabody test (normed on L1 children, not L2 learners), ‘content’ knowledge (Silverman and Hines, 2009), or knowledge of function words (Tsou et al., 2002).

Four studies investigated the effects of multimedia presentation on vocabulary acquisition. All four present positive findings. The first two (Tsou, Wang and Li, 2002; O’Hara and Pritchard, 2008) are broad media comparisons, in which a software programme featuring a range of media is compared with traditional classroom instruction. The third study (Silverman and Hines, 2009) focused on just one medium, video, comparing traditional instruction plus video with traditional instruction alone. The fourth (Kim and Gilman, 2008) evaluated the differential effects of a number of combinations of media (text; text and speech; text and graphics; text, speech and graphics; reduced text and speech; reduced text, speech and graphics) for the presentation of vocabulary within a CALL software programme.

To return to Tsou et al. (2002), they report that students receiving multimedia instruction improved knowledge of function words more than those receiving traditional classroom instruction. Similarly, O’Hara and Pritchard (2008) compared the effects of completing a hypermedia project in PowerPoint and a pen-and-paper project on students’ acquisition of topic-related vocabulary, finding that students in the hypermedia projects scored higher on the post-test of depth of vocabulary knowledge than those in the pen-and-paper projects. Likewise, Silverman and Hines (2009) found that both English language learners and native speakers presented with video clips to illustrate vocabulary items showed greater improvements in general vocabulary knowledge than those who did not receive multimedia instruction, and that use of the multimedia system narrowed the gap between L1 and L2 users. Finally, Kim and Gilman (2008) found that the use of graphics supported vocabulary acquisition, but the use of a combination of media did not.

A different approach to treatment was adopted by two studies (Nakata, 2008; Lu, 2008) in which different modes of sequencing and spacing vocabulary presentation were explored. Nakata used a computer to gradually increase the spacing between repetitions of vocabulary items and compared outcomes to fixed list presentation and flash card presentation. Nakata found an advantage for computer-controlled spacing and flash cards over lists, but no difference between computer-controlled spacing and flash cards. Lu (2008) investigated the use of text-messaging for the presentation of bite-sized vocabulary ‘lessons’ spaced throughout the day, during the learners’ commuting time. Lu found that students who received vocabulary instruction on their mobile phones learnt more vocabulary than those who received pen-and-paper instruction, but the advantage was not maintained at delayed post-test.

Chen and Li (2010) also investigated the effects of mobile learning on vocabulary acquisition, focusing on a personalised context-aware ubiquitous learning system which adapted the content of the vocabulary lessons delivered on a Personal Digital Assistant (PDA) to the learner’s proficiency, their location and the time of day. Learners working with the personalised context-aware system performed better than a control group working with a non-adaptive system on a post-test of vocabulary knowledge.

With another very different approach, Proctor, Dalton and Grisham (2007) investigated the effects of using a reading tutor, the Universal Literacy Environment (ULE), which provides students scaffolded reading instruction and strategy support through a bilingual avatar. This ‘pre-experiment’ (i.e. no control group), which compared the effectiveness of the tutor for Spanish learners of English and native speakers of English, found no significant gains from pre-test to post-test for either group, a result possibly explained by the short duration of the intervention, and also possibly by the small sample size (n = 14 L1, 16 L2).

Li (2010), investigated the impact of using mono- and bilingual electronic dictionaries equipped with text-to-speech synthesis for the provision of pronunciation models on the acquisition of receptive vocabulary knowledge by high school Chinese ESL students in Canada through extensive reading activities presented in *e-Lective* (Cummins, 1998;Dyned, 2011), a digital environment designed to support academic language learning. The study compared the impact of using electronic dictionaries embedded in the reading activities in *e-Lective* with the impact of using paper dictionaries and handheld dictionaries in conjunction with the reading activities in *e-Lective.* It found that students acquired more vocabulary with electronic dictionaries than in the control condition in which the students used paper or handheld dictionaries with *e-Lective*. The finding is possibly explained by the fact that students in the control condition, and the beginners in particular, looked up less words than the students in the experimental condition.

 The effects of participating in online discussion forums, with and without teacher support, were investigated by Zhang et al., (2007). No significant differences in vocabulary acquisition were found at post-test between the experimental groups and a control group not participating in the extra online activities, despite a reasonably long (5-week) intervention. However, there does not appear to have been any pre-testing, casting some doubt on the validity of the analysis. Sasaki and Takeuchi (2010) investigated the effects of participating in e-mail interactions with a native speaker on vocabulary acquisition. Here the native speaker expressly seeded target words into the e-mails sent to the learners to see whether learners would imitate the vocabulary used and whether imitation would lead to their acquisition. Results showed that learners imitated 60 of the 193 target words seeded in the e-mails, 36 of which were acquired. However, according to the learners, 16 of the 60 words were learnt outside the email exchange. Further, the learners acquired without imitation 39 of the words provided by the native speaker, 22 of these having also appeared in other contexts (e.g., English lessons).

This review of vocabulary studies appears to indicate some possible language learning benefits in the use of CALL. However, we would argue that the results are inconclusive in terms of claiming that CALL facilitates vocabulary acquisition, because of problems in study design and data analysis methodology: the choice of statistical tests is often open to question, and although some researchers report statistically significant results, they rarely report effect sizes. The picture is confused by the very varied applications and approaches used in the interventions and the lack of homogeneity of outcome variables. The outcomes are not always relatable to a body of previous research evidence or theorizing, because there is little discussion of why a particular technological feature should facilitate a particular aspect of vocabulary acquisition.

**6.2.2 Evidence from grammar studies**

Three studies focused on grammar, and two were judged to make a medium or higher contribution to this review question (Appendix E). The outcome variables in these studies were: a reduction in the error rate of finite verbs in main clauses in written compositions (Coniam and Wong, 2004); and a general unspecified notion of ‘English grammar’ (Zhang et al., 2007), although this study, as noted above, looked at a range of outcomes.

These studies explored whether grammar would improve following participation in chat (Coniam and Wong, 2004) or discussion forums (Zhang et al., 2007). Previous (non-technology) SLA research into grammar acquisition has tended to focus on the relative benefits of explicit/deductive versus implicit/deductive teaching and learning. Neither study under review related its findings to any grammar acquisition theory. In any case no significant differences were found between groups; thus neither study provided evidence that CALL facilitates grammar acquisition.

**6.2.3 Evidence from pronunciation studies**

Only one of the three pronunciation studies meeting the inclusion criteria also met the quality criteria. This study, Neri, Mich, Gerosa and Giuliani (2008), reported an evaluation of the asr-based Computer-Assisted Pronunciation Training (CAPT) system *parling*. Each module of the *parling* CAPT system focuses on a story. The system reads the story aloud while displaying it on-screen. Some words are hyperlinked to their meanings and model pronunciations. Learners can record themselves pronouncing the selected word. Feedback (correct/incorrect) is provided through asr. The experimental group (N=13) received four 30-minute sessions of training with *parling* whereas the control group (arguably a group receiving a different treatment) (N=15) received four 60-minute sessions of training with the classroom teacher. The latter were given a paper copy of the story which the teacher read aloud, explaining the meaning of some words, and providing a pronunciation model which the students repeated. It is unclear whether feedback on mispronunciation was given to this group. The words in both conditions were selected to cover the most frequent phonemes of British English and classified according to difficulty level (easy/known vs. difficult/unknown). Neri et al. found that both groups made equal progress with pronunciation, a finding that they claim is of some significance, given that the experimental group spent less time on task. They also found that students’ pronunciation of difficult words improved more than their pronunciation of easy words.

It would seem that the use of technology for improving pronunciation is worth exploring further. We state this tentatively, because Neri et al. (2008) was very small scale, only tested isolated word pronunciation, and did not test long term retention. Nevertheless one hopes that the number of studies in this field will increase as asr technology improves.

Having reviewed the research literature on linguistic knowledge, we now turn to research studies on the four language skills.

**6.2.4 Evidence from reading studies**

Of the 17 studies focusing on reading, only 7 were made a medium or higher contribution to this review. Here, we focus on the three not examined elsewhere in this report.

First we should note that very different aspects of reading were being investigated. Troia (2004), using *FastForWord* software, described one of his outcomes as ‘basic reading skills’ and used a standardized reading test of English (normed on L1 speakers of English), including a sound blending task, word identification and word attack tests (Woodcock and Johnson, 1990), whilst Tsou et al. (2006) using a multimedia storytelling website, measured story comprehension through students’ writing, thereby introducing an additional variable. Chen et al. (2010) measured reading comprehension through analysis of the tags that learners used to characterise texts. All these studies involved very different populations of students, ranging from primary classrooms in Taiwan to children of migrant workers in the US.

The findings of these studies are inconclusive. In the Troia study there was no main effect of treatment on basic reading skills and in fact the control group outperformed the experimental group on sound blending and rhyming. In the Tsou et al. study, gains on the story comprehension measure were similar for the two groups after ten weeks of instruction. In contrast, Chen et al., investigating the impact of social-tagging on reading comprehension found that students who worked with the system which integrated social-tagging and discussion forums performed better on a post-test of reading comprehension than those who worked with the system which only integrated discussion forums.

In summary, there is a lack of clear advantage for CALL technologies in the area of reading in the L2.

**6.2.7 Evidence from listening studies**

Five of the eight listening studies met the inclusion criteria for this review.

Of these five studies, only two focused explicitly on listening (and speaking). The first, Verdugo and Belmonte (2007), investigated the use of interactive digital stories (Kindersite, 2009) on listening proficiency, operationalized by tests devised by the authors. 260 six-year old Spanish children were drawn from six schools in Madrid, with classes designated experimental or control. Interactive digital stories were used as part of the experimental group’s lessons. After controlling for differences at pre-test the researchers found that the experimental groups outperformed the controls. The second study (Liu and Chu, 2010) investigated a ubiquitous (i.e. mobile) game-based system for developing English listening and speaking skills. The system incorporated a virtual representation of the children’s school campus in Taiwan. Each location on the virtual campus contained links to audio and video recordings of the types of conversation that the learner might have there. The children first explored the virtual campus from their classroom, practising speaking and listening skills. They then took the system out into the real world campus to complete a treasure hunt game. During this part of the activity, they could access further audio and video recordings and related activities to practise situation-related speaking and listening. At each location, they were also set simulated conversation activities. Each completed activity was rewarded. Use of the ubiquitous game-based system was compared with using printed materials and a CD. Children in the experimental group outperformed those in the control group on post-tests of listening.

The remaining three studies, Greenfield (2003), Troia (2004) and Lin and Wu (2010), investigated the impact of participating in a collaborative e-mail exchange focusing on the production of a writing anthology, using the FastForWord program discussed previously and using netboooks respectively on a range of language skills and sub-skills. While Greenfield (2003) found that students participating in the e-mail exchange increased their confidence in listening, Troia (2004) found no differences between the group which worked with the FastForWord software and the group which received regular instruction on the listening comprehension sub-test of Carrow-Woolfolk’s (1995) *Oral and Written Language Scales*, and Lin and Wu (2010) observed no differences in the listening scores for the students that used the netbooks and the students that did not.

For these five listening studies, the evidence for the effectiveness of CALL appears to be conflicting. However, this may simply be because three of the studies did not focus explicitly on listening. The two which did found an advantage for technology.

**6.2.5 Evidence from writing studies**

Of the 17 studies which were identified as focusing on writing, ten focused on writing alone. The most popular technology in these (all post-2005) was wikis. cmc technologies, specifically, e-mail, chat and discussion forums, were also popular. These writing studies tended to employ qualitative rather than quantitative methods, perhaps reflecting a view in writing that researchers should focus on processes rather than final products.

Only one of these ten studies of writing made a medium or higher contribution to this review question. Mak and Coniam (2008), who measured the effects of a wiki-based activity on Hong Kong secondary students’ writing via a quantitative analysis of the amount, quality and type of the writing produced over a six week intervention, found improvements in the amount of writing, in the length of texts and in the discourse features of these texts. Students’ revisions of discourse features were classified as adding, expanding, reorganising, or correcting ideas; most revisions involved adding new ideas, with correcting being least frequent. Mak and Coniam also evaluated qualitatively how the wiki was used as a collaborative writing platform. Non-linguistic outcomes of writing research will be discussed in Section 6.3.2.

That only one of the seventeen writing studies made a medium or above contribution to this review question suggests that those working on the use of technology for the development of L2 writing skills may need to be more rigorous in their study design.

**6.2.6 Evidence from speaking studies**

Four of the nine studies looking at the possible facilitating effect of CALL were judged to make a substantial contribution to the review.

The first of these was Troia (2004), already reviewed in the reading section. For speaking, Troia’s comparison of use of the *FastForWord* software integrating synthetic speech (waveform manipulation) with normal classroom instruction found no effect for treatment on oral language skills.

Satar and Ozdener (2008) considered the benefits of cmc, text chat, and voice chat on speaking proficiency for a sample of 90 participants from a secondary school in Turkey, randomly assigned to three equal groups: one received a voice chat treatment, another a text chat treatment, and a third no intervention. However, the 40- to 45-minute treatment was in addition to normal classroom instruction. The researchers found significant differences at post-test between the voice chat and control group and between the text chat and control on a range of speaking proficiency measures, with the experimental groups clearly benefiting from the intervention, but no difference between the two experimental groups. Although this is positive, the question remains whether it was the technologies or extra time on learning tasks that produced these results.

The final two studies (Liu, 2009; Liu and Chu, 2010) investigated a ubiquitous game-based system for developing English speaking and listening skills. They found that children who used the ubiquitous game-based learning system, described in detail in section 6.2.7, outperformed those in the control group on the post-test of speaking as well as that of listening.

In sum, for these four studies we do not have consistent findings that technology facilitates the speaking skill more than non-technology pedagogy, but there is a strong suggestion that combining the two can lead to speaking gains.

**6.3 Review question 3: Insights into CALL**

We have so far reviewed in depth studies investigating the use of CALL to facilitate or enhance acquisition and skill development. We will now look for insights about possible non-linguistic benefits of using technology in language learning - categorized as follows: learners’ attitudes to CALL; learners’ strategic behaviour; confidence and anxiety.

**6.3.1 Learners’ attitudes to CALL instruction**

Lu (2008) investigated attitudes towards the mini-lessons sent to Taiwanese grade 10 students’ mobile phones in terms of convenience, interest, facilitation of memorization, ease and frequency of access. More than 50% of students appreciated the convenience and time management involved; and individual students found creative ways of adapting the pedagogy, e.g. the student who constructed sentences from the target words and sent them back in for feedback. Some less positive attitudes were expressed: only 25% of the participants reported enjoying the novelty and only 17% reported appreciating receiving the messages for memorization.

More consistently positive attitudes were expressed in Nakata’s (2008) comparison of different vocabulary learning methods with 15-17 year old Japanese learners. 70% of the students using computer-based training expressed overall satisfaction, compared to only 40% and 30% in the groups using card and paper systems respectively. The computer-based group also found the training less boring, although the author speculates the novelty value may have played its part here. O’Hara and Pritchard (2008) also reported positive reactions from younger learners in California (10-11 year olds) to a hypermedia project using *PowerPoint*: participants reported better recall, more available information and more control over their learning. Reactions to the context-aware ubiquitous learning system investigated by Liu and Chu (2010) were also positive. Students enjoyed using the system, found it helpful and appreciated its presentation format and active nature.

Taken together, these studies provide tentative evidence of positive attitudes towards CALL. However, one must exercise caution in interpreting these results. The majority of the studies were less than a term in duration. Indeed, Lu’s (2008) study was conducted over only two weeks and Nakata’s (2008) study was conducted over a single lesson. Hence the results are likely to have been affected by novelty. Only Liu and Chu (2010) was longer, conducted over eight weeks.

**6.3.2 Learning Behaviours**

Five studies focusing on learning behaviours met the criteria of medium or high contribution to the review.

With respect to critical thinking, Zhang et al. (2007) found that students who received teacher support during online discussions discussed the topics in greater depth than those who did not receive such support.

Chandrasegaran and Kong (2006) found that students participating in discussion forums demonstrated argumentation skills which they already mastered in oral interaction, but had had difficulty using in academic expository writing. *Stance*, an expression of the student’s position in relation to the topic of discussion or a response to another student’s position, was observed in 137 (87%) of the 159 postings analysed, and *stance-support* – reasons or grounds for a particular position – was observed in 75 (55%) of postings expressing stance. This was a descriptive study not evaluating the use of technology. However, the suggestion from the authors is that the technology did provide better opportunities for stance taking than if, say, the students had been involved in normal face-to-face group activities, because of the non-threatening aspect of the technology.

Collaborative learning behaviours were the focus of two studies by Lan, Sung and Chang (2007) with third-grade Taiwanese students. In the first, whole class reading was compared to group work reading (neither using technology). The researchers found that group leaders differed in their approach: while some helped lower-ability students, others ignored them and read individually; others even teased them. Group leaders often asked students of intermediate ability to read alone. In the second study, the researchers compared Mobile Peer-Assisted Learning (MPAL) system supported group-work with group work unsupported by technology. They found significantly fewer learning-unrelated behaviours in the mpal class than in the comparison class, and found that conflict-oriented group work was significantly lower in the mpal class.

Other positive findings with regard to students appropriating the tools of their learning are reported in Parks et al. (2005), where initially students carried out the steps of the writing process to comply with the teacher, but over time started using process writing in other classes, not because they had done it previously, but because they understood its utility.

Like Parks et al. (2005), Mak and Coniam (2008) investigated the effects of technology use on students’ use of the writing process. Students worked for six weeks in groups of four producing brochures about their school. In the first week, the students were introduced to the project and to wikis. They then spent five weeks working on the project, after which the brochures were printed out and distributed to parents. Qualitative analysis revealed that students began by generally discussing the topic and posting their comments to the wiki, and then simply adding to existing text. As the project progressed, they began to edit each others’ writing and alternately developed and expanded on the existing wiki.

These studies, then, find that technology-based classes can develop certain behaviours at least as well as, and sometimes better than, face-to-face learning: teachers can support language learners’ critical thinking effectively in online discussions; students can scaffold each other in L2 argumentation skills online; language learners tend to work in groups in a more focused and cooperative manner online than face-to-face; learners working in groups via wikis gain in confidence and independence; and learners transfer writing skills learnt in technology-based language lessons to other learning contexts.

**6.3.3 Confidence and anxiety**

Of the non-linguistic outcomes reported in the articles selected for review, only two investigated the link between use of CALL and foreign language learning (FLL) anxiety. The scarcity of interest in this topic is surprising for two reasons. Firstly, FLL anxiety has been extensively researched (since the seminal work by Horwitz, Horwitz and Cope, 1986), both from a skills perspective and from a situation perspective, both of which might have been of interest to CALL researchers. Secondly, there is anecdotal evidence that peer pressure can have negative effects on learning in traditional classroom settings and we would have expected to see more research comparing whole class learning with computer-based individual learning.

Only one of these studies (Satar and Ozdener 2008) looked into language learning anxiety. Recall that this compared the effects voice chat and text chat discussions centred around information gap, problem solving, jigsaw and decision making activities. Anxiety levels decreased for both voice chat and text chat, but not for the control group. The decrease in anxiety levels was only significant for the students in the text chat condition; and anxiety when communicating with L2 native speakers was higher in the voice chat condition than in the text chat condition. The authors conclude that it might be beneficial to start with text chat, especially for low-proficiency students. A future review whose primary focus is the non-linguistic effects of CALL might provide a more detailed picture of which technologies used with which pedagogical activities work best to minimise language learning anxiety.

Two other studies investigated students’ confidence. While Tsou et al. (2006) found that students expressed greater confidence as a result of multimedia storytelling activities, Liu and Chu (2010), who compared use of a context-aware ubiquitous learning system with comparable pen-and-paper activities, found that students’ confidence to apply the knowledge that they had acquired was greater in the experimental condition than in the control condition. Students in the experimental condition attributed their increase in confidence to the opportunity to engage in real learning experiences not found in books and speaking activities. However, there was no group difference in levels of self-efficacy with respect to the activities in the intervention.

We will now attempt to synthesize some of these review findings, make suggestions for improvements both in future conceptualizations of CALL research and in the methodology used therein. Finally we identify areas where further research is needed.

**7. Synthesis and discussion**

We have already summarized above our findings in relation to the keyword mapping process.

Here we summarise the 47 studies which, as a result of imposing the inclusion criteria (EFL and post-2000), were reviewed in-depth:

* There was a relatively even balance between studies conducted in primary (40%) and secondary (60%) schools.
* A much larger percentage of studies focused on writing (36%), reading (36%) and vocabulary (32%), than on speaking (19%) or listening (17%), which in turn substantially outnumbered studies of grammar (6%) or pronunciation (6%).
* Studies of grammar and writing more frequently involved secondary than primary students. Conversely, studies focusing on pronunciation, reading and listening more frequently involved primary than secondary students.
* The technologies most frequently studied were multimedia (21%) and cmc (23%).
* There was more research on word processors, the internet, cmc and web 2.0 with secondary than primary students, and more research on multimedia with primary students than secondary students.
* Regarding methodology, most studies employed mixed methods (49%) and there is an even balance between the use of quantitative (28%) and qualitative methods (23%).

**7.1 Contribution of the in-depth review to answering the review questions**

**7.1.1 What technology and why?**

With respect to the question of ‘why’ the technologies were investigated, our review revealed that, where indicated, most of the studies were policy-driven rather than driven by educational theory. It is interesting that policies generally focus on the need for the population to be digitally literate, as opposed to the proven and potential benefits of technology use in language learning. Ideally, future research would focus on how technology can be used to provide better conditions for language learning, as suggested by educational theory (Chapelle, 2001).

This exhaustive search of the literature on CALL in primary and secondary teaching of English as an L2 has not yielded clear or sufficient evidence of the effectiveness of technology. This is of some concern given the very large amounts of funding that are being made available worldwide for the purpose of encouraging the use of technology in language teaching. Of course, we can only argue that the research evidence available is inconclusive. This is not to say that there is not good practice involving CALL that simply has not been researched.

From the reviewed work on vocabulary, it would be difficult to recommend that technology in general or a specific piece of software should be used to improve vocabulary development. What little research has been conducted on the facilitative effect on grammar is also very inconclusive. In writing, as we have already indicated, the focus has been less on improving writing skill (fluency, accuracy and complexity) and more on investigating the process. Nevertheless, there is some indication that technology may help to develop certain academic writing skills better than pen and paper or even word processors; but the evidence is still very slight.

Interestingly, it was in speaking and pronunciation studies that some tentative evidence for the effectiveness of CALL was found, although the number of studies was very small. There is potential therefore for future studies to take this further. There is the possibility that conventional teaching where technology does not feature can be enhanced by some additional technology-based pronunciation and speaking activities.

Having painted this rather pessimistic picture, it is possible that we need to review our conceptualization of the effectiveness of CALL on language learning outcomes. This may not simply be a question of moving the goalposts for the ‘traditional classroom’ but of rethinking what is being compared. A striking finding in more than one study was that the strongest effect was not from a CALL-only condition or a non-CALL-only condition but from a combination of typical classroom/teacher support with CALL methodology. Another interesting conclusion in one study (Kim and Gilman, 2008) was that the learners were not able to benefit from the CALL methodology because they did not have prior skills that would allow them to do so. This points to future research avoiding a simple binary design and including combinations of CALL with classroom or teacher support and ICT skill building in the conditions studied, as one would with any other innovation in pedagogy/classroom practice.

While some feel that the normalization of technology in education means that it is no longer necessary to justify the cost effectiveness of CALL (Garrett, 2009), it is clear from this review that it may still be necessary to ask whether CALL – on its own or in combination with traditional approaches – is more effective than traditional approaches alone. It is clear from the review that a much more rigorous methodology is needed. Firstly, one needs to isolate the key feature of each technology which makes it different from non-CALL pedagogy. An obvious example of this is that more advanced technologies can offer individual learners individualized feedback on spoken utterances, something that is more difficult in a large class of learners with one teacher. Having identified a key feature in the technology one might then go on to relate this to theories of language learning – in this case perhaps the use of recasts and other forms of error correction, linked to the development stage of the individual learner (Philp, 2003), again something more difficult in the large class with one teacher. Finally one would need to make a decision about the kind of comparison being made. If the comparison is simply of non-technology with technology, one would need to consider time on task and other variables. If the condition of interest is non-technology *plus* technology, one needs to measure magnitude of gains against time taken away from other activities. All these issues and covariates need to be thought through and justified much more than they have been to date if there is going to be some rigorous theorizing centred around CALL.

Unless these different approaches to CALL research are investigated we will continue to be confronted with well meaning studies which offer teachers, learners, and educational administrators very little guidance. Moreover, if researchers continue to carry out broad comparison studies it will be difficult for them to build a body of evidence that is generalizable to new technologies and their applications to language learning. This is important, given the pace at which technology is evolving.

If this review has produced few answers to our review question regarding the facilitative effect of CALL on language learning outcomes, it has been more productive in offering insights about attitudes and learner behaviours.

A number of studies have shown that technology use can qualitatively change students’ learning experiences. There is evidence that learners have positive attitudes towards CALL, and that a number of higher-level strategies and classroom behaviours may be improved by the use of a variety of technologies. These results in this area once again highlight the need to reassess notions of effectiveness and approaches to technology evaluation. A different learning tool may produce different learning behaviours which are beyond linguistic outcomes but are no less educationally valid. This points to the desirability of starting from what is known about how primary and secondary learners acquire an L2 and investigating whether there are affordances of the technology which may accommodate this acquisition better than typical classroom configurations.

**7.2 Quality of the research reviewed**

In assessing the contribution of 47 studies to the overall review, as described above, two independent reviewers judged each study according to a number of criteria. The results are not encouraging (Appendix E). For our research question regarding the facilitative effect of CALL on language learning outcomes, only six studies (Troia, 2004; Zhang et al., 2007; Nakata, 2008; Satar and Ozdener, 2008; Chen and Li, 2010; Chen et al., 2010) were judged to have made a ‘high’ contribution to the first of our review questions. Unfortunately, one of these studies found no effect for the CALL condition. Of the remaining studies reviewed in-depth, 16 were judged to have made a Medium contribution and 25 a Low contribution. That is *not* to say that the studies were not relevant to answering our review questions (see relevance ratings in Appendix E). Many of them indeed were asking precisely the kinds of questions that we wanted to try to answer. However, the design and methodology employed did not lead the reviewers to accept the trustworthiness of a substantial number of studies. Let us look at this issue in more detail.

In the vast majority of studies, generalizability does not appear to be considered as important by researchers. Although populations are generally referred to or at least implied, it is not clear what marks them out as special or different from other populations. Moreover, sampling frames are almost never provided. Consequently it is impossible to ascertain how the sample is supposed to match the population. For example, are all secondary schools in one country so similar that a sample taken from one school represents the behaviour of secondary students across this country? Or should the researchers have considered different geographic locations, socio-economic status, different entrance requirements to different schools, different funding provision (*inter alia* for technology), and so on? Perhaps researchers do not consider generalizability to be important. Perhaps all they wish to do is to narrate what happened with one group of participants. However, when considering changes to new pedagogies and the costs involved, then some attempt should be made to at least match the sample to the population, even if that population has to then be described in quite circumscribed terms (e.g. grade 4 children in urban Taiwan as opposed to primary school children the world over).

The second problem we observed in many studies was a design validity one. Too often participants were assigned to experimental and ‘control’ conditions without any explanation of how this had been done. Instruments were inadequately described and insufficiently piloted. Often it was claimed that progress had been measured even though no pre-testing had, apparently, been carried out; and some of the statistical procedures that were adopted did not inspire confidence.

In terms of analysis we often found a reliability problem, with only very rare examples of intra- or inter-rater reliability procedures. This puts into doubt analyzer impartiality and analyzer error.

Perhaps our strongest criticism is reserved for the many studies which simply did not make the link between the learners they were researching, the technology that was being investigated and the theories related to the outcome variables they were testing. In other words this related to our ‘what technology and why’ review question. It would seem to us important to understand what motivation a study of CALL has, especially if the research is not an evaluation of a new piece of software that many schools are adopting. We need to ask the question why this CALL research is being done with this group of students at this point in time, and relate this to the potential for theory building in SLA.

**8. Conclusions**

This systematic review sought to provide a general overview of research in CALL since 1990 in the primary and secondary education phases, where governments are investing large quantities of funds in technology. The reason for this investment is most often framed as the need for a technologically competent population. However, whatever the reasons for the investment, we believe, as applied linguists, that the potential language learning benefits of technology need to be investigated.

We also sought to identify, in some depth, CALL research in primary and secondary EFL/ESL in the first decade of the 21st century. We have done so in terms of both its impact on SLA and its potential for creating a different learning environment – our insights question. We conclude, particularly in the case of impact, that the research is too diffuse and too wide-ranging, and does not build on previous work to contribute to any theory of language learning. In order to improve this situation, we suggest that the reasons for carrying out the research with particular populations are clearly expressed and argued. We also ask that attributes of technology are clearly identified and rigorously tested for their contribution to language learning, and that the research in general aims for much higher levels of quality.

We hope that researchers will aspire to this, as we believe that both the research community and practitioners are very much in need of having this evidence available to them.

**Acknowledgements**

To be added after peer-review process.

**Appendix A: Acronyms and technical terms**

|  |  |
| --- | --- |
| ASR | See ‘Automatic Speech Recognition’ |
| Authoring software | Software which allows teachers to create their own CALL exercises by entering content into a choice of pre-defined exercises templates. |
| Automatic Speech Recognition  | ‘Speech recognition is the process of converting an acoustic signal, captured by a microphone or a telephone, to a set of words’ (Zue, Cole and Ward, 1996: Web). In language learning ASR is typically used to rate learners’ pronunciation and for the detection of pronunciation errors. |
| Avatar | A computer-generated graphical representation of a person. |
| Blog (or weblog) | Topic-oriented ‘websites consisting of dated entries typically listed in reverse chronological order on a single page’ (Kolari, Finin and Joshi 2006, p. 92). |
| CALL | See ‘Computer-Assisted Language Learning’ |
| CAPT | Computer-Assisted Pronunciation Training |
| Chat | ‘A form of CMC that most often refers to synchronous on-line communication’ (Blake, 2008, p. 151) |
| Chatbot | A piece of software which simulates a human conversation. |
| CLIL | Content and Language Integrated Learning |
| CMC | See ‘Computer Mediated Communication’ |
| Computer Mediated Communication | ‘Any program that allows learners to exchange language – through text or audio.’ (Blake, 2008: 152). For example, e-mail, discussion forums, chat. |
| Computer Supported Collaborative Learning | Tools which allow learners to work together on-line at a distance. Examples include file sharing applications and on-line collaborative work spaces. |
| Computer-Assisted Language Learning | ‘The search for and study of applications of the computer in language teaching and learning’ (Levy, 1997: 1) |
| CSCL | See ‘Computer Supported Collaborative Learning’ |
| Dialogue system | A system which incorporates ASR and TTS synthesis technologies, in order to permit the learner to have a conversation with the computer. |
| Discussion forums (forums or electronic bulletin boards) | ‘This term refers to an on-line message board where posts are displayed chronologically or in threaded discussions’ (Blake, 2008: 152). |
| EFL | English as a Foreign Language |
| EPPI Centre | Evidence for Policy and Practice Information and Co-ordinating Centre |
| ESL | English as a Second Language |
| Hypermedia | ‘Hypermedia refers to similar links as those used in hypertext, but instead of simply linking text to text, hypermedia involves linking various media, such as sound, images, animation, and/or video’ (Beatty, 2003: 38). |
| ICT | Information and Communication Technologies |
| IT | Information Technology |
| IWB | See ‘Interactive Whiteboard’ |
| Interactive Whiteboard | ‘An IWB is basically a surface onto which a computer screen can be displayed via a projector. It is touch-sensitive, which means that all applications on the computer can be controlled by touching the board, either with your finger or with an electronic pen/stylus. Through interaction with whiteboard, the users can change the displayed information on the computer and save them for later use’ (Schmid, 2009) |
| L1 | First language |
| L2 | Second language |
| MPAL | Mobile Peer-Assisted Learning System |
| Multimedia | ‘Multimedia offer two of more communication channels such as video and text’ (Beatty, 2003:234). |
| Netbook | Small, lightweight, inexpensive laptops. |
| Newsgroups | An online discussion group dedicated to a particular topic. Users send messages to a central server which then distributes the messages to the entire discussion group. The messages can be picked up by users using either a dedicated newsreader or an e-mail client. |
| NLP | Natural Language Processing |
| Parser-based CALL | Also referred to as Intelligent CALL (ICALL), parser-based CALL refers to CALL software which integrates parsing technology to identify errors in learners’ responses to open-response questions and provide feedback on those errors, where a parser is a technology which ‘produces a formal linguistic representation of natural language by identifying the grammatical function of the parts of a sentence’ (Heift and Schulze, 2009: 2). |
| PC | Personal Computer |
| Simulation | Simulations are branching programs which allow learners to explore the consequences of their actions in a given situation (Beatty, 2003). Some well-known examples are *Yellow River Kingdom*, a simulation of a rice growing economy, *GB Ltd*, a simulation of the British economy, and *Fast Food*, a simulation of a small business (Jones and Fortescue, 1987) |
| Social tagging | Social tagging allows users to attach keywords to on-line content (e.g., *Delicious, Stumble Upon*). |
| Text reconstruction | Text reconstruction refers to a class of CALL activities in which the learner is required to reconstitute a text from a partial text or a jumbled list of its components. Examples of text reconstruction activities include gap-fill, cloze, total text reconstruction, and text unscrambling (Hewer, 1997). |
| Text-based conferencing | An early form of e-mail. |
| Text-to-Speech Synthesis | TTS synthesis is the process of converting an input text to an acoustic signal. |
| TTS | See ‘Text-to-Speech Synthesis’ |
| Turtle logo | A programming language developed for use in educational contexts. Turtle Graphics was the most famous component. Based on constructionist principles, the idea was that the learner could teach the computer to construct an object and vice versa. |
| Video conferencing | A technology which allows users to engage in synchronous interaction via two-way video and audio. |
| Videodisc | ‘A high-volume storage system’ which ‘featured rapid access to multiple points or ‘chapters’ on a disk and had better pause, or freeze frame, features along with the possibility of advancing one frame at a time through set of video or still (e.g. photographic) images or images/pages of text’ (Beatty, 2003: 23). |
| Virtual Learning Environment | Also referred to as ‘learning platforms’, ‘course management systems’, ‘content management systems’, and ‘learning management systems’, a virtual learning environments is ‘[a]n ICT mediated space giving access to organised information and resources that learners,individually or in groups, can make use of in order to improve their understanding of a given subject’ (Holtham and Courtney 2005, 4). |
| Virtual worlds | Computer-simulated immersive environments in which users can interact with one another and objects. |
| VLE | See ‘Virtual Learning Environment’ |
| Waveform manipulation | The acoustic modification of speech signals using speech visualisation and editing software, e.g. Wavesurfer or PRAAT, to enhance acoustic cues such a stress placement or pitch contours. |
| Web 2.0 | Web 2.0 is the ‘‘writable web’’ (Karpati, 2009: 140). It encompasses any technology which allow users to publish their own content (user-generated content). Blogs, wikis and podcasts are all examples of Web 2.0 technologies. |
| Wikis | A wiki is a ‘freely expandable collection of interlinked web pages, a hypertext system for storing and modifying information – a database, where each page is easily edited by any user with a forms-capable Web browser client’ (Leuf and Cunningham, 2001:14). |

**Appendix B: Search strategy**

The general search strategy was as follows:

language

AND

learning

 AND

(computer OR technology OR individual technologies)

AND

(primary OR secondary)

NOT

(pre-school OR postsecondary OR special education OR teacher training OR online processing)

**Appendix C: Tables 1-4**

Table 1 Studies by linguistic knowledge and skills, study date and phase of education (P = primary, S= secondary; n = 117; studies not mutually exclusive by linguistic knowledge and skills)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Linguistic knowledge and skills** | **1991-1995** | **1996-2000** | **2001-2005** | **2006-2010** | **Total** |  |
|  | **P** | **S** | **P** | **S** | **P** | **S** | **P** | **S** | **U** | **P** | **S** | **Total** |
|  | **n=5** | **n=17** | **n=6** | **n=5** | **n=9** | **n=7** | **n=26** | **n=41** | **n=2** | **n=46** | **n=70** | **n=117** |
| **Vocabulary** | 2 | 6 | 1 | 1 | 4 | 0 | 4 | 10 | 0 | 11 | 17 | 28 |
| **Grammar** | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 2 | 0 | 2 | 6 | 8 |
| **Pronunciation** | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 3 | 0 | 3 |
| **Reading** | 1 | 3 | 2 | 1 | 2 | 2 | 8 | 7 | 0 | 13 | 13 | 26 |
| **Writing** | 0 | 6 | 1 | 1 | 0 | 5 | 6 | 8 | 1 | 7 | 20 | 28 |
| **Speaking** | 0 | 2 | 0 | 1 | 1 | 1 | 4 | 4 | 0 | 5 | 8 | 13 |
| **Listening** | 2 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 0 | 6 | 6 | 12 |
| **Other/not indicated** | 0 | 5 | 2 | 2 | 3 | 1 | 8 | 2 | 1 | 13 | 24 | 36 |

Table 2 In-depth review studies by country and year (N=47, not mutually exclusive by country)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **Total** |
| **Country** | **n=0** | **n=1** | **n=2** | **n=3** | **n=1** | **n=4** | **n=5** | **n=13** | **n=7** | **n=11** | **n=47** |
| **Brazil** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| **Canada** | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 3 |
| **China** | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| **Hong Kong** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Italy** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| **Japan** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| **Korea** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| **Lebanon** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| **Malaysia** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 |
| **Norway** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| **Singapore** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 2 |
| **South Korea** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| **Spain** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| **Taiwan** | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 2 | 3 | 5 | 14 |
| **Turkey** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| **UK** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| **US** | 0 | 0 | 1 | 1 | 0 | 1 | 2 | 1 | 1 | 0 | 7 |

Table 3 In-depth review studies by technology and linguistic knowledge and skills (N=47 studies, not mutually exclusive by technology or linguistic knowledge and skills)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Technology** | **Vocabulary** | **Grammar** | **Pronunciation** | **Reading** | **Writing** | **Speaking** | **Listening** |
| **Phase** |  | **P** | **S** | **P** | **S** | **P** | **S** | **P** | **S** | **P** | **S** | **P** | **S** | **P** | **S** |
|  |  | n=5 | n=10 | n=0 | n=3 | n=3 | n=0 | n=9 | n=8 | n=6 | n=11 | n=4 | n=5 | n=4 | n=4 |
|  | **Unspecified technology** | 0 | 1 | 0 | 1 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
|  | **Laptops** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
|  | **Word processors** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
|  | **Typing tutor** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
|  | **Power Point** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 1 | 0 |
|  | **Art software** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
|  | **ElectronicDictionary** | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 1 | 0 | 1 | 0 |
|  | **Textreconstruction** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Multimedia** | **Graphics** | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Text** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Animation** | 3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Video** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Audio** | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|  | **Hypermedia** | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Web** | **Web-based** | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **Websearch** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| **Webpagecreation** | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 |
| **(CMC)** | **E-mail** | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 2 | 0 | 1 | 0 | 1 |
| **Newsgroups** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| **Chat** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| **Discussionforums** | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 4 | 0 | 0 | 0 | 0 |
| **Videoconferencing** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
|  | **CSCL** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| **Web2.0** | **Wikis** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| **Blogs** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 |
|  | **Social tagging** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mobiles** | **Textmessaging** | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mobilepeer-assistedlearning** | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|  | **Virtualworlds** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 |
|  | **Corpus** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **NLP** | **Parser-basedcall** | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
|  | **ASR** | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
|  | **TTS** | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
|  | **Waveformmanipulation** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
|  | **E-books** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
|  | **Storytellingsoftware** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
|  | **Authoringsoftware(forstudents)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
|  | **Games** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
|  | **VLEs** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
|  | **Digital photography** | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
|  | **Robot** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
|  | **Augmented reality** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |

Table 4 Studies by technology and study date (N=117, not mutually exclusive by technology)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **1991-1995** | **1996-2000** | **2001-2005** | **2006-2010** | **Total** |
|  |  | **n=22**  | **n=11** | **n=16** | **n=68** | **n=117** |
|  | **Unspecified technology** | 4 | 0 | 1 | 5 | 10 |
|  | **Telephone** | 1 | 0 | 0 | 0 | 1 |
|  | **Fax** | 1 | 0 | 0 | 0 | 1 |
|  | **Laptops** | 0 | 0 | 0 | 1 | 1 |
|  | **CD-ROMs** | 0 | 0 | 2 | 2 | 4 |
|  | **Word processors** | 6 | 0 | 2 | 1 | 9 |
|  | **Typing tutor** | 0 | 0 | 0 | 1 | 1 |
|  | **PowerPoint** | 0 | 0 | 0 | 2 | 2 |
|  | **Art software** | 0 | 0 | 0 | 1 | 1 |
|  | **Electronic dictionaries** | 1 | 0 | 0 | 3 | 4 |
|  | **Electronic encyclopedia** | 1 | 0 | 0 | 0 | 1 |
|  | **Text reconstruction** | 3 | 0 | 1 | 3 | 7 |
|  | **Simulation** | 2 | 0 | 0 | 0 | 2 |
| **Multimedia** | **Videodisc** | 1 | 0 | 0 | 0 | 1 |
| **Text** | 2 | 0 | 0 | 1 | 3 |
| **Graphics** | 4 | 0 | 2 | 5 | 11 |
| **Animation** | 0 | 0 | 2 | 2 | 4 |
| **Video** | 1 | 2 | 0 | 3 | 6 |
| **Audio** | 5 | 0 | 2 | 4 | 11 |
|  | **Hypermedia** | 3 | 2 | 1 | 5 | 11 |
| **Web** | **Web-based** | 0 | 1 | 3 | 7 | 11 |
| **Web search** | 0 | 1 | 1 | 2 | 4 |
| **Web publishing** | 0 | 1 | 3 | 2 | 6 |
|  | **Network-based** | 1 | 0 | 0 | 0 | 1 |
| **CMC** | **E-mail** | 4 | 4 | 3 | 3 | 14 |
| **Newsgroups** | 0 | 0 | 1 | 0 | 1 |
| **Chat** | 1 | 1 | 3 | 4 | 9 |
| **Discussion forums** | 0 | 0 | 1 | 7 | 8 |
| **Bulletin boards** | 1 | 0 | 0 | 0 | 0 |
| **Video conferencing** | 0 | 0 | 0 | 2 | 2 |
|  |  **CSCL** | 0 | 1 | 0 | 7 | 8 |
| **Web 2.0** | **Blogs** | 0 | 0 | 0 | 3 | 3 |
| **Wikis** | 0 | 0 | 0 | 5 | 5 |
| **Social networks** | 0 | 0 | 0 | 1 | 1 |
| **Social tagging** | 0 | 0 | 0 | 1 | 1 |
| **Mobiles** | **Text messaging** | 0 | 0 | 0 | 1 | 1 |
| **Mobile peer-assisted learning** | 0 | 0 | 0 | 2 | 2 |
|  |  **VLEs** | 0 | 0 | 1 | 1 | 2 |
|  | **Virtual worlds** | 0 | 1 | 1 | 6 | 8 |
|  | **Corpus** | 0 | 0 | 0 | 1 | 1 |
| **NLP** | **Parser-based CALL** | 1 | 0 | 0 | 4 | 5 |
|  **ASR** | 0 | 1 | 0 | 5 | 6 |
|  **TTS**  | 1 | 0 | 0 | 3 | 4 |
| **Wave form manipulation** | 0 | 0 | 1 | 0 | 1 |
| **Dialogue systems** | 0 | 1 | 0 | 3 | 4 |
| **Chatbots** | 0 | 0 | 0 | 3 | 3 |
| **Adaptive systems** | 0 | 0 | 0 | 2 | 2 |
|  | **E-books** | 0 | 2 | 1 | 2 | 5 |
|  | **Storytelling software** | 0 | 0 | 0 | 1 | 1 |
|  | **Games** | 0 | 1 | 2 | 3 | 6 |
|  | **Authoring software (for students)** | 0 | 0 | 0 | 1 | 1 |
|  | **Interactive whiteboards** | 0 | 0 | 0 | 3 | 3 |
|  | **Online fan fiction** | 0 | 0 | 0 | 1 | 1 |
|  | **Digital photography** | 0 | 0 | 0 | 2 | 2 |
|  | **Robots** | 0 | 0 | 0 | 3 | 3 |
|  | **Augmented reality** | 0 | 0 | 0 | 2 | 2 |
|  | **Physically interactive learning environment** | 0 | 0 | 0 | 1 | 1 |

**Appendix D: Keyword map**

**Note/Key:**

NI The information was ‘not indicated’ in the paper.

Sex M = Male; F = Female; Mix = Mixed; NI = Not indicated

L1 Where the first language of the participants was not indicted in the paper, either the country from which the participants originated or the country in which the study was conducted is indicated in the ‘first language’ column in capital letters.

Method Quant = Quantitative; Qual = Qualitative; Mixed = Mixed methods

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Author** | **Date** | **Language areas and skills** | **Technology** | **Country** | **Educational setting** | **Sex** | **L1** | **L2** | **Method** | **Sample** |
| Abbott *et al.* | 1998 | Reading | E-books, Hypermedia | US | Primary | NI | Mandarin, Japanese | English | Qual | 4 |
| Aharony | 2006 | Deep vs surface learning | Web, Web-based, Hypermedia | Israel | Secondary | Mix | ISRAEL | English | Mixed | 148 |
| Almekhlafi | 2006 | Language proficiency | CD-ROM, Multimedia, Video, Audio | UAE | Primary | NI | UAE | English | Mixed | 83 |
| Almekhlafi | 2006 | NI | CD-ROM, Multimedia | UAE | Secondary | NI | UAE | English | NI | 90 |
| Anderson | 2001 | Writing | Web, Web publishing, Word processors | UK | Secondary | NI | English | Urdu, Bengali | Qual | 37 |
| Austin & Mendlick | 1993 | Language proficiency, Cultural awareness | CMC, E-mail | Ireland, Germany | Secondary | NI | English, German | English, German  | Mixed | NI |
| Baten *et al.* | 1999 | CLIL: Art, Involvement | CMC, E-mail, Web, Web-based | Belgium | Secondary | NI | French, Dutch, German | French, Dutch, German | Qual | NI |
| **Author** | **Date** | **Language areas and skills** | **Technology** | **Country** | **Educational setting** | **Sex** | **L1** | **L2** | **Method** | **Sample** |
| Beauvois | 1992 | Language proficiency | CMC, Chat | US | Secondary | M | English | French | Qual | 1 |
| Black | 2010 | Writing | Web 2.0, online fan fiction | NI | NI | NI | NI | NI | Qual | NI |
| Bueno & Nelson | 1993 | Listening | Hypercard | US | Primary | Mix | English | Spanish | Mixed | 7 |
| Cardillo | 1996-7 | Vocabulary, Grammar | Multimedia, Video | US | Secondary | F | English | French | Mixed | 20 |
| Carel | 1999 | Pragmatics | Hypermedia, Multimedia, Video | US | Secondary | NI | English, Japanese, Cantonese, Farsi, Portuguese, Polish | French | Qual | 23 |
| Chandrasegaran &Kong | 2006 | Writing | CMC, Discussion forums | Singapore | Secondary | Mix | Mandarin, Malay, Tamil | English | Qual | NI  |
| Chang & Chen | 2010 | NI | Robots | NI | Primary | NI | NI | English | Qual | NI |
| Chang et al. | 2010 | NI | Robots | Taiwan | Primary | NI | TAIWAN | English | Qual | 3 classes |
| Chen and Li | 2010 | Vocabulary | Mobile, Context-aware | Taiwan | Secondary | Mix | TAIWAN | English | Mixed | 36 |
| Chen et al. | 2010 | Reading | Web 2.0, Social tagging, CSCL | Taiwan | Secondary | NI | TAIWAN | English | Mixed | 36 |
| Choi | 2009 | Identity | Web 2.0, Wikis | NI | Secondary | NI | ASIAN | English | Qual | 4 |
| Cohen | 1993 | Writing | NLP, TTS | France | Primary | NI | Non-francophone | French | Qual | NI |
| Coniam & Wong | 2004 | Grammar, Autonomy | CMC, Chat | China | Secondary | F | Cantonese | English | Mixed | 26 |
| Dekhinet *et al.* | 2008 | Writing | CMC, E-mail, Chat, Videoconferencing, Discussion boards | UK, Spain | Primary | NI | Spanish, English | English, Spanish | Qual | 49 |
| Ehsani *et al.* | 2000 | Speaking, Attitudes | NLP, Dialogue, ASR | US | Secondary | NI | English | Japanese | Mixed | 34 |
| Espada *et al.* | 2006 | Interface preferences | Adaptive systems, Hypermedia | Spain, US | Primary | NI | English, Spanish | English Spanish | Mixed | NI |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Author** | **Date** | **Language areas and skills** | **Technology** | **Country** | **Educational setting** | **Sex** | **L1** | **L2** | **Method** | **Sample** |
| Fidaoui *et al.* | 2010 | Writing | Word processors, PowerPoint, Typing tutor, Art software, Web, Web search | Lebanon | Primary | Mix | LEBANON | English | Mixed | 48 |
| Freeman &Crawford | 2008 | CLIL: Mathematics, Language proficiency | Web, Web-based, Multimedia | US | Secondary | NI | Spanish | English | Mixed | 154 |
| Gaine & Salazar Noguera | 2006 | NI | Web, Web-based | Spain | Secondary | NI | Spanish | FOREIGN | Qual | NI |
| Ganszauge *et al.* | 1994 | Attitudes | Word processors, Multimedia, Graphics, Encyclopaedia, Text reconstruction | Finland | Secondary | Mix | Finnish | English | Mixed | 194 |
| Greenfield | 2003 | Reading, Writing, Speaking, Listening, Attitudes | CMC, E-mail | Hong Kong, US | Secondary | NI | Cantonese | English | Mixed | 45 |
| Greifnieder | 1995 | Vocabulary | Multimedia, Audio, Graphics | Germany | Secondary | Mix | NI | German | Quant | 70 |
| Herselman | 1999 | Language proficiency | Games | South Africa | Primary | Mix | Xhosa | English | Mixed | 90 |
| Ho *et al.* | 2009 | Critical thinking  | Virtual worlds, CMC, Discussion forums | Singapore | Secondary | Mix | SINGAPORE | English | Qual | 45 |
| Jakobsdottir & Hooper | 1995 | Listening | Multimedia, Text, Audio | US | Primary | Mix | English | Norwegian | Quant | 109 |
| Jaspers *et al.* | 1993 | Vocabulary, Reading | Electronic dictionary, Text reconstruction, Multimedia, Audio, NLP, Parser-based CALL | NI | Secondary | NI | NETHERLANDS | English | Mixed | 64 |
| Jia | 2009 | Attitudes, Usage | NLP, Chatbots, Dialogues systems | China | Secondary | Mix | Mixed | English | Mixed | 1783 |
| Jia and Chen | 2009 | Attitudes, Usage | NLP, Chatbots, Dialogues systems | China | Secondary | Mix | Mixed | English | Mixed | 1783 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Author** | **Date** | **Language areas and skills** | **Technology** | **Country** | **Educational setting** | **Sex** | **L1** | **L2** | **Method** | **Sample** |
| Jiyou | 2009 | Language proficiency, Attitudes | Web, Web-based, Dialogue system, Text reconstruction | China | Secondary | NI | CHINA | English | Mixed | 45 |
| Johns *et al.* | 2008 | Reading | Corpus, Text reconstruction | Taiwan | Secondary | Mix | TAIWAN  | English | Mixed | 22 |
| Johnston & Milne | 1995 | Speaking, Listening, Culture | Multimedia, Video, Videodisc | US | Secondary | NI | English | French | Mixed | 43 |
| Kang | 1995 | Vocabulary | Hypermedia, Multimedia, Text, Audio, Graphics | South Korea | Primary | NI | Korean | English | Quant | 103 |
| Kang & Dennis | 1995 | Vocabulary | Hypermedia, Hypercard, Multimedia, Graphics | Korea | Primary | NI | Korean | English | Quant | 26 |
| Ketteman | 1995 | Reading, Writing, Speaking, Listening | Text reconstruction, Simulations | Austria | Secondary | Mix | German | English | Quant | 527 |
| Kim & Gilman | 2008 | Vocabulary | Web, Web-based, Multimedia, Graphics, Audio | South Korea | Secondary | NI | Korean | English | Quant | 172 |
| Knee *et al.* | 2000 | CLIL: Geography and Language arts, Thinking skills | CMC, E-mail | US, Finland, Slovenia | Primary | NI | English, Finnish, SLOVENIA | English | Quant | 79 |
| Kramsch | 2000 | Reading, Writing | CMC, Chat, Web, Web search, Web publishing | US | Secondary | NI | HONG KONG | English | Qual | 1 |
| Lai *et al.* | 2009 | Pronunciation, Reading, Spelling  | NLP, ASR | Taiwan | Primary | Mix | TAIWAN  | English | Quant | 120 |
| Lam & Pennington | 1995 | Vocabulary, Grammar, Writing | Word processors | China | Secondary | M | Cantonese | English | Quant | 17 |
| Lam | 2004 | Identity | CMC, Chat | US | Secondary | F | Cantonese | English | Qual | 2 |
| Lan *et al.* | 2007 | Reading | CSCL, Mobile, MPAL  | Taiwan | Primary | Mix | TAIWAN  | English | Mixed | 52 |
| Lan *et al.* | 2009 | Reading | CSCL, Mobile, MPAL  | Taiwan | Primary | NI | TAIWAN  | English | Mixed | 52 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Author** | **Date** | **Language areas and skills** | **Technology** | **Country** | **Educational setting** | **Sex** | **L1** | **L2** | **Method** | **Sample** |
| Langman & Fies | 2010 | Meaning –making | IWBs, clickers | US | Secondary | NI | Farsi, Hindi, Korean, Kirundi, Punjabi, Spanish  | English | Qual | 12 |
| Li | 2009 | Vocabulary, Reading | Electronic dictionary, Text reconstruction, NLP, TTS, Parser-based CALL | Canada | Secondary | Mix | CHINA  | English | Qual | 24 |
| Li | 2010 | Vocabulary, Reading | Electronic dictionary, NLP, TTS | Canada | Secondary | Mix | Mandarin | English | Quant | 20 |
| Liaw | 1997 | Reading | E-books | US | Primary | Mix | French, Spanish, Chinese, Hindi, Farsi, Korean, Polish | English | Mixed | 14 |
| Ligorio *et al.* | 2008 | Intersubjectivity | Virtual worlds | Italy | Secondary | NI | Italian | English | Qual | 10 |
| Lim | 2008 | Global citizenship, Attitudes, Engagement, Motivation | Games, Virtual World, Web, Web search | Singapore | Primary | Mix | Mandarin | English | Qual | 80 |
| Lin & Yi-Juin | 2010 | Reading, Writing, Listening, Speaking, Attitudes, Behaviours | Laptops, Electronic dictionary, PowerPoint, VLE, Digital photography, Audio recording | Taiwan | Primary | NI | TAIWAN | English | Mixed | 89 |
| Liu *et al.* | 2010 | Attitudes | Web 2.0, Social networking | Taiwan | Secondary | Mix | TAIWAN | English | Quant | 492 |
| Liu | 2009 | Listening, Speaking | Mobile, Augmented reality | Taiwan | Secondary | NI | TAIWAN | English | Quant | 64 |
| Liu & Chu | 2010 | Listening, Speaking | Mobile, Augmented reality | Taiwan | Secondary | NI | TAIWAN | English | Quant | 64 |
| Lopez | 2010 | NI | IWBs | NI | Primary | NI | NI | English | Quant | NI |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Author** | **Date** | **Language areas and skills** | **Technology** | **Country** | **Educational setting** | **Sex** | **L1** | **L2** | **Method** | **Sample** |
| Lu | 2008 | Vocabulary | Mobile, Text messaging | Taiwan | Secondary | Mix | TAIWAN  | English | Mixed | 30 |
| Luck | 2008 | Reading | Web, Web publishing, Hypermedia | US | Secondary | NI | English | German | Mixed | 46 |
| Lund | 2008 | Writing | Web 2.0, Wikis | Norway | Secondary | NI | Norwegian | English | Qual | 31 |
| Lund & Rasmussen | 2008 | Writing | CSCL, Web 2.0, Wikis | Norway | Secondary | Mix | Norwegian | English | Qual | 31 |
| Mak & Coniam | 2008 | Writing | Web 2.0, Wikis | China | Secondary | Mix | HONG KONG | English | Mixed | 24 |
| Matthews-Ayninli and Elaziz | 2010 | NI | IWB | NI | Primary | NI | NI | English | Quant | NI |
| Milton & Garbi | 2000 | Vocabulary | CSCL, Virtual world | UK, Greece | Primary | NI | Greek, English | English | Mixed | NI |
| Morris | 2005 | Vocabulary, Grammar | VLE, CMC | US | Primary | Mix | English | Spanish | Qual | 46 |
| Morton & Jack | 2010 | Speaking | NLP, ASR, Virtual world | UK, China | Secondary | Mix | English, Mandarin | French, English | Quant | 76 |
| Murphy | 2009 | Speaking | CSCL | Canada | Primary | Mix | English | French | Qual | 92 |
| Nakata | 2008 | Vocabulary | Adaptive systems | Japan | Secondary | Mix | Japanese | English | Mixed | 217 |
| Narciss & Koerndle | 2008 | NI | CSCL | NI | Secondary | NI | NI | English | NI | 25 |
| Neri *et al.* | 2008 | Pronunciation | NLP, ASR | Italy | Primary | NI | Italian | English | Quant | 28 |
| Ngu & Rethinasamy | 2006 | Grammar | Multimedia, Graphics, Animation | Malaysia | Secondary | NI | MALAYSIA | English | Mixed | 30 |
| Nutta *et al.* | 2002 | Language proficiency | Multimedia | NI | Primary | NI | NI | Spanish | Mixed | NI |
| O’Hara & Pritchard | 2008 | Vocabulary, Concepts | Hypermedia | US | Secondary | NI | Spanish | English | Mixed | 40 |
| Parks *et al.* | 2005 | Writing | Web, Web publishing | Canada | Secondary | Mix | French | English | Qual | NI |
| Peng *et al.* | 2006 | Writing | Multimedia, Authoring (child) | US | Primary | NI | 6 COUNTRIES | English | Qual | 10 |
| Poulsen *et al.* | 2007 | Reading | NLP, ASR, Multimedia, Text, Audio, Graphics | US | Primary | Mix | Spanish | English | Quant | 34 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Author** | **Date** | **Language areas and skills** | **Technology** | **Country** | **Educational setting** | **Sex** | **L1** | **L2** | **Method** | **Sample** |
| Proctor *et al.* | 2007 | Vocabulary, Reading | Web, Web-based, Web-publishing, Hypermedia, Multimedia, NLP, TTS | US | Primary | Mix | Spanish, English | English | Mixed | 30 |
| Ritter | 1993 | Vocabulary, Writing | Word processors | Germany | Secondary | NI | German | English | Mixed | 29 |
| Sanaoui & Lapkin | 1992 | Writing | Network-based, CMC, E-mail | Canada | Secondary | NI | English | French | Mixed | 10 |
| Sasaki and Takeuchi | 2010 | Vocabulary | CMC, E-mail | Japan | Secondary | Male | Japanese | English | Mixed | 10 |
| Satar & Ozdener | 2008 | Speaking, Anxiety, Attitudes | CMC, Chat | Turkey | Secondary | F | Turkish | English | Mixed | 90 |
| Seedhouse | 1995 | Pragmatics | Simulation | NI | Secondary | NI | Spanish | English | Qual | 2 |
| Segers & Verhoeven | 2005 | Phonological awareness | CD-ROM, Games | Netherlands | Primary | Mix | MOROCCO, TURKEY, SURINAME | Dutch | Quant | 100 |
| Segers & Verhoeven | 2003 | Vocabulary | CD-ROM, E-books, Games, Multimedia, Audio, Graphics | Netherlands | Primary | Mix | MOROCCO, TURKEY, SURINAME | Dutch | Quant | 164 |
| Silver & Repa | 1993 | Writing, Self esteem | Word processors | US | Secondary | NI | Heterogenous | English | Mixed | 66 |
| Silverman & Hines | 2009 | Vocabulary | Multimedia, Video | US | Primary | Mix | English, Haitian creole, Portuguese, Mandarin, Spanish | English | Quant | 85 |
| Soares | 2008 | Reading, Writing | Web 2.0, Blogs | Brazil | Secondary | NI | BRAZIL | English | Qual | 16 |
| Soh &Soon | 1991 | Writing, Reading | Word processors, CMC, E-mail, Bulletin Boards | Singapore, Canada | Secondary | NI | French, CHINESE | English | Qual | NI |
| **Author** | **Date** | **Language areas and skills** | **Technology** | **Country** | **Educational setting** | **Sex** | **L1** | **L2** | **Method** | **Sample** |
| Suh *et al.* | 2010 | Reading, Writing, Listening, Speaking | Games | Korea | Primary | NI | KOREA | English | Quant | 220 |
| Svenconis & Kerst | 1995 | Vocabulary | Hypercard, Hypermedia, Audio | US | Secondary | NI | English | Spanish | Mixed | 48 |
| Swann | 1992 | Grammar | Unspecified technology | Italy | Secondary | Mix | Italian | English | Mixed | 25 |
| Tan *et al.* | 2009 | Writing | CMC, Chat, Discussion forums, Web 2.0, Blogs | Malaysia | Secondary | Male | MALAYSIA | English | Qual | 31 |
| Taylor *et al.* | 2005 | Writing | Word Processors | UK | Secondary | Mix | English | German | Qual | 1 class |
| Tella | 1992 | NI | CMC, E-mail | Finland, UK, US | Secondary | Mix | Finish, English | English, Finish | Qual | 134 |
| Thorne | 2009 | Attitudes, Usage | CMC, Chat, Web 2.0, Blogs | USA | Secondary | NI | English | Spanish | Qual | 28 |
| Trenchs | 1996 | Writing | CMC, E-mail | US | Primary | NI | English | Spanish | Qual | 3 |
| Troia | 2004 | Reading, Speaking, Listening, Phonological awareness | NLP, Waveform manipulation | US | Primary | Mix | Spanish, English | English | Quant | 191 |
| Tsou *et al.* | 2002 | Vocabulary, Attitudes | Web, Web-based, Hypermedia, Multimedia, Graphics, Animation, Audio, CMC, E-mail | Taiwan | Primary | NI | TAIWAN | English | Mixed | 74 |
| Tsou *et al.* | 2006 | Reading, Writing | Multimedia, Storytelling software | Taiwan | Primary | NI | TAIWAN  | English | Mixed | 70 |
| Tzortzidou & Hassapis | 2001 | Reading | Unspecified technology | Greece | Primary | NI | Greek | French | Quant | 149 |
| Van Bussel | 1994 | Vocabulary | Unspecified technology | Netherlands | Secondary, Primary | NI | Dutch | English | Quant | 141 |
| Verdugo & Belmonte | 2007 | Listening, Reading | E-books | Spain | Primary | NI | Spanish | English | Mixed | 220 |
| Verhallen *et al.* | 2006 | Vocabulary, Grammar, Comprehension | E-books, Multimedia, Video, Audio, Graphics | Netherlands | Primary | Mix | Turkish, Morrocan Arabic, Berber | Dutch | Quant | 60 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Author** | **Date** | **Language areas and skills** | **Technology** | **Country** | **Educational setting** | **Sex** | **L1** | **L2** | **Method** | **Sample** |
| Ward | 2004 | Motivation, Interest | Web, Web-based, Text reconstruction | Ireland | Primary | NI | English | Irish | Mixed | 100 |
| Wong & Looi | 2010 | Vocabulary | Multimedia, Animation, CMC, Discussion forums, Web 2.0, Wikis, Mobile, Digital photography | Singapore | Primary | NI | Chinese | English | Qual | 80 |
| Yang & Chen | 2007 | Attitudes | CMC, E-mail, Video conferencing, Chat | Taiwan | Secondary | M | TAIWAN | English | Qual | 44 |
| Yang *et al.* | 2010 | Language proficiency | Physically interactive learning environment | Taiwan | Primary | Mix | TAIWAN | English | Mixed | 60 |
| Yanqing & Qi | 2004 | Pronunciation, Vocabulary | Multimedia, Animation | China | Primary | M | Mandarin | English | Quant | 67 |
| Young | 2003 | Reading, Writing | Web, Web publishing, CMC, Chat, Discussion forums, E-mail, Newsgroups, Virtual worlds | Taiwan | Secondary | Mix | TAIWAN  | English | Mixed | 29 |
| Young *et al.* | 2010 | Speaking, Attitudes | NLP, ASR, Robots | Taiwan | Primary | Mix | TAIWAN | English | Mixed | 68 |
| Yun *et al.* | 2008 | Vocabulary | Web, Web-based | South Korea | Secondary | NI | Korean | English | Quant | 122 |
| Zha *et al.* | 2006 | Communicative competence | CMC, Discussion boards | US | Primary | Mix | Spanish, Chinese, Russian, French, Korean, Arabic, Pohnpeian, Urdu, Samoan | English | Mixed | 28 |
| Zhang *et al.* | 2007 | Reading, Writing, Grammar, Vocabulary, In-class discussion, Critical thinking | CMC, Discussion forums | China | Secondary | NI | CHINA  | English | Mixed | 54 |
| **Author** | **Date** | **Language areas and skills** | **Technology** | **Country** | **Educational setting** | **Sex** | **L1** | **L2** | **Method** | **Sample** |
| Zheng *et al.* | 2009 | Writing | Virtual world | China | Secondary | Mix | CHINA  | English | Qual | 61 |

**Appendix E Weight of evidence for studies included in the in-depth reviews**

[Tables 5 to 11]

**References**

Notes:

† indicates that the study was identified through the systematic search and included in the *keyword map*.

‡ indicates that the study was identified through the systematic search and reviewed in-depth.

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1. This is a considerable limitation given that only 31 of the 117 articles that we identified as meeting the criteria for inclusion in our broad map featured in the four CALL-related journals considered by Stockwell (2007), namely *CALICO Journal*, *Computer-Assisted Language Learning*, *ReCALL*, and *Language Learning & Technology*. [↑](#endnote-ref-1)
2. It was not possible to determine the methodology from the study abstracts in the remaining two studies. [↑](#endnote-ref-2)