Education Endowment Foundation

Remote Learning:

Rapid Evidence Assessment

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The Education Endowment Foundation (EEF) is an independent charity dedicated to breaking the link between family income and educational achievement, ensuring that children and young people from all backgrounds can fulfil their potential and make the most of their talents.

The EEF aims to raise the attainment of children facing disadvantage by:

- identifying promising educational innovations that address the needs of disadvantaged pupils in primary and secondary schools in England;
- evaluating these innovations to extend and secure the evidence on what works and can be made to work at scale; and
- encouraging schools, government, charities, and others to apply evidence and adopt innovations found to be effective.

The EEF was established in 2011 by the Sutton Trust as lead charity in partnership with Impetus (formerly Impetus Trust) and received a founding £125m grant from the Department for Education. Together, the EEF and Sutton Trust are the government-designated What Works Centre for improving education outcomes for school-aged children.

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Contents

Executive summary

Introduction

This rapid evidence assessment aimed to investigate methods that schools could use to support remote learning during school closures caused by the 2020 coronavirus pandemic (Covid-19). The review sought to find the best evidence behind the wide array of approaches that schools might choose to use during the crisis.

The review systematically searched for/through existing meta-analyses and systematic reviews to find the best evidence for a wide range of approaches. In addition to the direct teaching of pupils online by teachers, the review also found evidence for approaches that pupils can use independently, including with technology that adapts the content of tasks in order to provide additional challenge or support, educational games, and for approaches that support peer interaction.

The review also examined blended learning approaches, which combine remote and classroom teaching. While these approaches may not be directly applicable during school closures, they were included in case there were useful lessons to be learned that were relevant to the current context of home learning.

This report summarises the findings from 60 systematic reviews and meta-analyses answers under five key topic areas:

- General remote teaching and learning
- Blended learning
- Computer-supported collaborative learning
- Computer assisted instruction
- Educational games

Another crucial aspect of supporting pupil's learning is parental engagement. Parental engagement approaches are beyond the scope of this review, but an existing EEF **guidance report, Working with Parents to Support Children's Learning (2019),** and accompanying **evidence review** summarise the best available evidence for engaging parents in their children's education.

In each section, we have detailed the included reviews and listed ***Findings and implications*** drawn from the evidence. We have also highlighted case studies from projects funded by the Education Endowment Foundation in which similar approaches have been rigorously evaluated in English schools.

Limitations

It is important to note the limitations of applying existing evidence to school shutdowns due to Covid-19. None of the studies examined measure impacts on learning during a global pandemic, and there are characteristics of the current situation that will be unique, including due the demands of parents working from home, staff illness and other restrictions related to social distancing.

In addition, there are other important limitations to the evidence. Few high-quality studies have looked at remote learning in school-aged education, and many of the included reviews combine evidence from school-aged education, university education and adult learners. This means that some approaches may be particularly applicable to older pupils, and careful consideration is required in assessing transferability to school contexts. Other evidence comes from programmes that have the potential to be delivered remotely – for example, intelligent tutoring systems – but that have to date largely been evaluated within classrooms.

The rapid nature of the review also means that this review does not provide statistical analysis or comparisons between different approaches or reviews, but instead provides a narrative summary of findings. While each systematic review and meta-analysis included was appraised for quality, it was rare for the reviews themselves to appraise the quality of included studies comprehensively. This is a notable limitation of this body of evidence.

These limitations notwithstanding, this report aims to summarise evidence that may support teachers in making decisions related to remote instruction during periods of school shutdown.

Safeguarding

When considering the remote teaching approaches discussed in this review, it is important to consider aspects of safeguarding. The National Society for the Prevention of Cruelty to Children (NSPCC) has produced resources on safeguarding during remote teaching, which can be found **here**.

Key findings and implications

1. Teaching quality is more important than how lessons are delivered

Pupils can learn through remote teaching.

Ensuring the elements of effective teaching are present – for example clear explanations, scaffolding and feedback – is more important than how or when they are provided. There was no clear difference between teaching in real time ("synchronous teaching") and alternatives ("asynchronous teaching").

For example, teachers might explain a new idea live or in a pre-recorded video. But what matters most is whether the explanation builds clearly on pupils' prior learning or how pupils' understanding is subsequently assessed.

2. Ensuring access to technology is key, particularly for disadvantaged pupils

Almost all remote learning uses digital technology, typically requiring access to both computers and the internet.

Many reviews identify lack of technology as a barrier to successful remote instruction. It is important that support is provided to ensure that disadvantaged pupils – who are more likely to face these barriers – have access to technology.

In addition to providing access to technology, ensuring that teachers and pupils are provided with support and guidance to use specific platforms is essential, particularly if new forms of technology are being implemented.

3. Peer interactions can provide motivation and improve learning outcomes

Multiple reviews highlight the importance of peer interaction during remote learning, as a way to motivate pupils and improve outcomes.

Across the studies reviewed, a range of strategies to support peer interaction were explored, including peer marking and feedback, sharing models of good work, and opportunities for live discussions of content.

The value of collaborative approaches was emphasised in many reviews, although notably many studies involved older learners. Different approaches to peer interaction are likely to be better suited to different age groups.

4. Supporting pupils to work independently can improve learning outcomes

Pupils learning at home will often need to work independently. Multiple reviews identify the value of strategies that help pupils work independently with success.

For example, prompting pupils to reflect on their work or to consider the strategies they will use if they get stuck have been highlighted as valuable.

Wider evidence related to metacognition and self-regulation suggests that disadvantaged pupils are likely to particularly benefit from explicit support to help them work independently, for example, by providing checklists or daily plans.

5. Different approaches to remote learning suit different tasks and types of content

Approaches to remote learning vary widely and have different strengths and weaknesses. Teachers should be supported to consider which approaches are best suited to the content they are teaching and the age of their pupils.

For example, games for learning were found to have a high impact on vocabulary learning in foreign languages, but there is less evidence related to their use in other subjects.

Likewise, using technology to support retrieval practice and self-quizzing can help pupils retain key ideas and knowledge, but is not a replacement for other forms of assessment.

The evidence in this review is drawn from diverse contexts that do not closely parallel the circumstances facing schools responding to Covid-19 in 2020. Many forms of digital technology could in theory be used to support remote learning, but are typically used in schools and have not been evaluated as remote learning tools. In all cases, it is important for teachers and school leaders to use their professional judgement in determining the support they provide their pupils and to monitor its impact on learning.

Methods

We undertook a rapid evidence assessment of existing systematic reviews and meta-analyses. We were guided by the Cochrane Collaboration Rapid Reviews Methods Group interim guidance on producing rapid reviews (Garrity et al. 2020), as well as the Civil Service Rapid Evidence Assessment methodological guidance (Government Social Research Service, 2009) and the Cochrane Collaboration's guidance on overviews of reviews (Pollock et al. 2020). A protocol for this Rapid Evidence Assessment, including more detail about the methodological approach taken, was published on the EEF website and is available **here**.

Search criteria overview

The scope was limited to systematic reviews and meta-analyses in order to respond quickly to the policy challenge of school closures due to Covid-19. The review was limited to studies from 2005 or later, as technology-based approaches from pre-2005 are unlikely to be relevant to current online learning approaches. To be included in the REA, a study had to meet the following additional criteria:

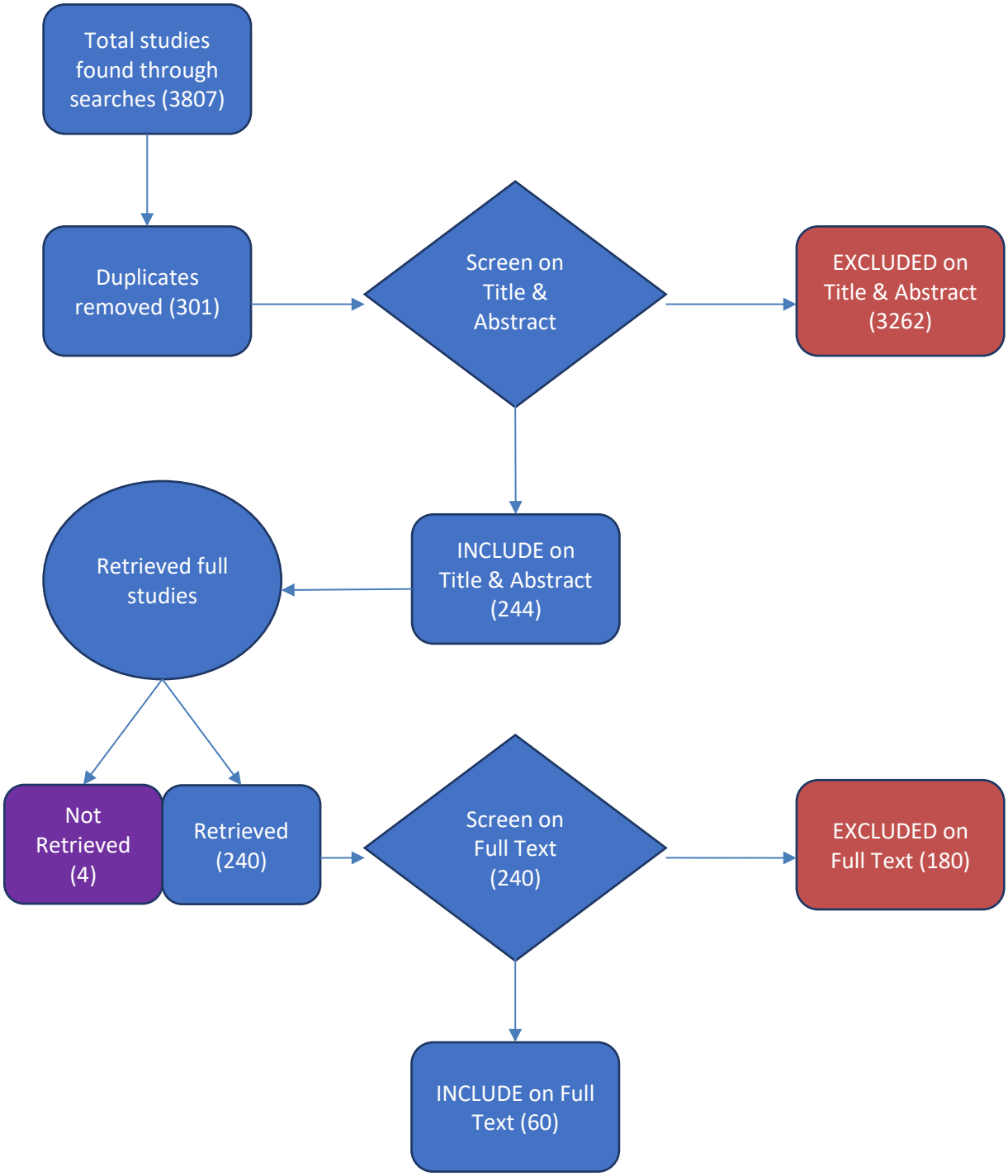
- Population: include studies of interventions with primary or secondary aged pupils. We included reviews of studies from any country.
- Intervention: include studies of distance learning approaches as methods of teaching that take place entirely outside of the classroom environment. They could be synchronous or asynchronous. The primary objective needed to be pupil learning outcomes. Examples of included approaches could be:
    - Recreating the classroom environment through online platforms such as "Google Classrooms" or equivalents
    - Online tutoring that provides intensive support to individual pupils through a two-way link
    - Digital platforms/education software that are used independently by pupils
    - Online lectures without pupil interaction
    - Games for learning (GL)
    - We included blended learning approaches but examined them separately for information on best practice on schools setting learning for the home environment.
- Comparison: compare distance learning to classroom or school-based learning or other types of distance / online based approaches
- Outcome: cover any measure of academic achievement or cognitive measure of ability of pupils in any subject.
- Study design: be a meta-analysis or systematic review of distance learning effectiveness or implementation of distance learning

How the review was conducted

We undertook the following steps to produce the REA, as described in the protocol:

1. Searched for relevant studies, including searching bibliographic databases and known sources of systematic reviews.
2. Screened the search results for inclusion using the criteria described above using a two-stage process, first screening at title and abstract and then at full text level.
3. Extracted data from each included systematic review and meta-analysis, including information on methodological and substantive features, results, specifically average effect sizes and associated confidence intervals where presented, and any information around barriers and facilitators to successful implementation of distance learning approaches.
4. Appraised each systematic review and meta-analysis for methodological quality, to make a judgement on how much confidence to place in the findings of each review.
5. Summarised the findings of each included review, grouped by the broad topic they address.

Figure 1: PRISMA diagram of search process results



The initial searches returned 3846 references. After removing duplicates and screening on title and abstract, 244 references were labelled for inclusion. We were unable to retrieve 4 references, which meant that 240 were screened on full text. Of these 240, 60 reviews were included in the review. All 60 had data extracted. After data was extracted, findings fell into five broad categories, which are summarised in sections below:

- General remote teaching and learning (10 reviews)
- Blended learning (5 reviews)
- Computer assisted collaborative learning (5 reviews)
- Computer aided instruction (29 reviews)
- Learning games (14 reviews)

Some reviews covered multiple categories and are included in multiple sections. Where different pooled effects are reported in the review, these are reported in the relevant section.

Remote teaching and learning

The intervention

This section examines the reviews that have examined remote learning generally – it includes studies that have tried to measure the impact of combined approaches to distance learning and teaching directly through video conferencing software or other methods of online tuition.

Findings and implications:

- Whether the elements of effective teaching are present is less important than how or when they are provided.
- There is some evidence that encouraging peer interactions can lead to improved learning outcomes, particularly for older pupils, and that prompting pupils to reflect on their own learning during remote learning may be an effective approach.
- Overall, evidence about remote learning is limited and draws on studies from higher education, as well as on and older reviews. Findings are likely to be less applicable to primary-aged children than older pupils and may not reflect the latest technological changes.

Relevant studies

Review	Review focus	Number of studies	Reported impact
Bernard et al (2009)	An effect is provided for general distance learning. The review examines the impacts of different types of interaction in distance learning (for example, student-student or student-teacher)	74	0.38
Borokhovsk et. al. (2012)	An effect is provided for general distance learning. The review then examines the differences in types of student-student interaction in distance learning.	36	0.31
Chauhan (2017)	The meta-analysis covers technology impacts on education more generally. There is a specific focus on e-learning and the extracted effect size is for learning in informal settings, and not the overall impact of technology.	21 (for non-formal education settings, e.g. home)	0.70 (non-formal education settings, e.g. home)
Darabi et al. (2013)	This meta-analysis examined the impact of planned discussions as part of online teaching. The reported effect compares the impact of strategic discussion compared with conventional discussion in online learning.	8	0.50
Jopling (2012)	This paper reviews the literature for online one-to-one tuition.	17	N/A
Means et al. (2009)	This review combined a meta-analysis of distance learning and blended learning approaches with a qualitative review of remote learning approaches that took place exclusively with school-aged pupils.	46	0.24†
Means et al. (2013)	This review updates Means et al. (2009) removing coding errors in the earlier analysis and providing additional moderator analysis.	45	0.20 (0.14 p<.05 for online only instruction).
Sandy-Hanson (2006)	This review looked generally at the use of technology in supporting pupils learning, but contained separate analysis of remote learning.	5 (remote learning)	0.26
Vasquez III; Straub (2016)	This review examined the studies located by Means et al (2009) to identify the impacts of remote learning approaches for pupils with special educational needs (SEN).	4	0.38
Zhao Y et al. (2005)	This meta-analysis examines distance learning in comparison to face-to-face education. It combines solely online approaches and blended learning approaches.	51	0.10

† *This effect size had been updated in Means et al 2013 to remove coding errors. The effect size is reported here for record but is superseded by the later study.*

How secure is the evidence?

A number of meta-analyses have examined the impact of remote or distance learning. The evidence base is limited by the small number of rigorous studies that have taken place within school-aged education. Means et al (2009) reviewed distance learning approaches for children from kindergarten to grade 12 (4 to 19 year olds) in the USA and only located 9 studies that met the inclusion criteria. In order to estimate the impact of remote learning, they combined studies of school aged pupils with studies from higher education. While analysis within several of the reviews has not shown a

significant difference in outcomes between higher and compulsory education, the fact that many of the findings on successful types of remote learning are drawn from contexts other than school is a severe limitation to the applicability of the evidence.

We also appraised the quality of each included systematic review and meta-analysis. It was rare for the included reviews to appraise the quality or risk of bias of their included studies, a limitation of this body of evidence. We therefore do not have a clear understanding of the quality of the underlying research contributing to our conclusions.

What does the evidence say?

The limited amount of rigorous evidence notwithstanding, reviews that have examined the impact of distance learning have found that results are equivalent or slightly higher for pupils who have been taught through distance instruction rather than traditional face to face instruction. One study found that results are higher when blended and online learning are analysed together (Means et al 2013); when online teaching was examined individually the impact was found to be no different from traditional instruction.

One review (Bernard et al 2009) examined different types of interaction within distance learning, comparing student-student, student-teacher, and student-content, interaction. The review found evidence that student-student interaction had the largest impact on student outcomes. This finding is corroborated by the review by Means et al. (2013), which found a positive impact for interaction with peers, whether synchronous or asynchronous. A follow-up review to Bernard et al (Borokhvski et al 2012) found that when student-student interaction was designed into the distance learning the impact was even greater. These findings should be treated with caution due to the fact that, despite the review searching for school-aged interventions, the evidence was drawn exclusively from higher education studies. When another review (Darabi et al. 2013) examined the impact of planned strategic discussions between peers in comparison to conventional online discussions, the impact for all pupils was positive but there was no impact for school-aged pupils when higher education studies were removed from the analysis.

Several reviews explored different ways of presenting information and teaching. Means et al (2013) found no evidence that adding multimedia to online instruction had any impact on learning outcomes, concluding that the teaching was more important than the medium itself. There was, however, some evidence that supporting learners to reflect on their own learning had positive impacts. Zhao et al. (2005) found evidence that a combination of asynchronous and synchronous learning was most beneficial to outcomes. This finding is not replicated across other reviews, which found no evidence to differentiate either asynchronous or synchronous instruction (Means et al 2013 and Bernard et al 2009).

The evidence on remote learning for pupils in primary school is very limited. Future research is needed on the efficacy of remote learning for younger pupils.

How does the approach impact disadvantaged pupils?

None of the studies examined the impact of distance learning techniques on disadvantaged pupils. One study that focused on the implementation of one to one tuition highlighted the importance of access to technological infrastructure (Jopling 2012).

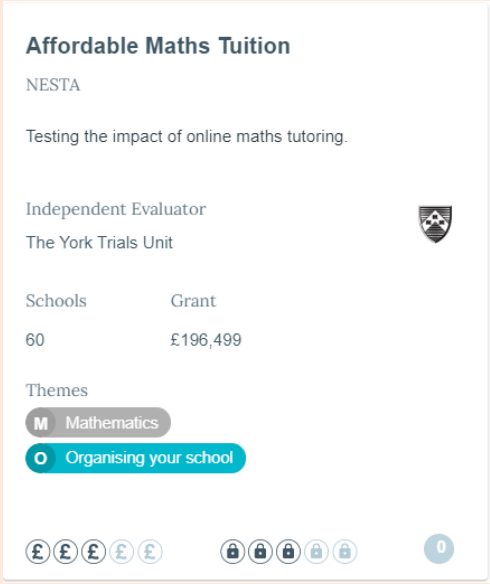
Relevant EEF-funded evaluations

The EEF has not funded any evaluations of school-wide distance learning approaches. There may be some transferable learning from one project, 'Affordable Maths Tuition', in which pupils received maths tuition from trained maths graduates based in Sri Lanka and India.

Teachers were largely positive about the online tuition, and reported that it appeared to improve pupils' comprehension, verbal fluency, and confidence in maths. However, the impact evaluation found no evidence that the intervention had an impact on Key Stage 2 maths, compared with 'business as usual' teaching and support in Year 6.

Some pupils complained they were interrupted when working as the tutor could not see that they were still tackling a problem. This may have been due to the lack of face-to-face contact with the tutors.

Tuition did not take place in the home learning environment, so findings may not be transferable, it is important schools consider how to track pupils progress with tasks and remove technological barriers to receiving instruction. The full evaluation report of 'Affordable Maths Tuition' can be found **here**.



Blended learning

The intervention

Blended learning combines aspects of online instruction with classroom teaching or activities. This means that the evidence may not be directly applicable to schools during periods of shutdown. These studies have been included to give insight into successful implementation of the distance components of blended learning approaches.

Findings and implications

- Lack of access to technology, particularly for disadvantaged pupils, is identified as a key barrier to the success of blended learning approaches.
- Peer marking was identified as a promising component of some blended learning schemes – particularly when pupil work and feedback is anonymised.
- Providing professional development to teachers implementing new approaches and using new platforms is identified as important.

Relevant studies

Review	Review focus	Number of studies	Reported impact
Cui and Zheng (2018)	This review focuses specifically on using peer evaluation – typically sharing essays with peers for feedback - in blended learning environments.	23	0.68
Means et al. (2009)	This review combined a meta-analysis of distance learning and blended learning approaches with a qualitative review of remote learning approaches that took place exclusively with school-aged pupils.	46	0.24
Means et al. (2013)	This review updates Means et al. (2009) removing coding errors in the earlier analysis and providing additional moderator analysis.	45	0.20 (0.14 p<.05 for online only instruction).
Poirier et al. (2019)	This review provides a narrative summary of different blended learning approaches.	11	N/A
Rasheed et al. (2020)	This review summarises barriers to implementing blended learning approaches effectively.	30	N/A

How secure is the evidence?

Only one review that measured the impact of blended learning approaches on pupil outcomes was identified (Means et al 2013). This study was conducted seven years ago and included a large number of studies from higher education. Two of the other reviews provided a narrative synthesis of blended learning approaches and important aspects of implementation, while the final review (Cui and Zheng 2018) focused specifically on the use of peer evaluation in blended learning environments. While some insights may be gained from the identified studies – in particular through identifying potential barriers to implementing blended learning approaches – practitioners should be cautious when applying findings to their own context.

We also appraised the quality of each included systematic review and meta-analysis. It was rare for the included reviews to appraise the quality or risk of bias of the included studies, a limitation of this body of evidence. We therefore do not have a clear understanding of the quality of the underlying research contributing to our conclusions.

What does the evidence say?

The one review that measured impact of blended learning approaches on learning found a positive result (Means et al 2013). Poirier et al (2019) conducted a systematic review into the evaluation of blended learning approaches and found that the evidence was mixed.

Similarly to the general reviews of remote learning, the value of communication between pupils was a highlighted by a number of the reviews (Means et al 2013, Poirer et al 2019, Cui and Zheng 2018). Poirer et al noted that a feature of some of the positive evaluations was the facilitation of peer to peer communication, examples including message platforms or online forums. Given the small number of studies, this result may not be transferable. Cui and Zheng (2018) examined peer evaluation more systematically across blended learning environments and found a positive effect. One of the interesting findings of the Cui and Zheng analysis is that anonymous peer marking of work had a higher impact on pupil outcomes, and that peer reviewing that was supported by teachers had a higher impact. Peer tutoring is a well-

evidenced approach in traditional teaching settings – for more information, see the Education Endowment Foundation Teaching and Learning Toolkit entry on Peer Tutoring, which can be found **here**.

Rasheed et al (2020) conducted a systematic review of implementation challenges of the online component of blended learning. Some of the highlighted challenges included supporting teachers' professional development in implementing online aspects of blended learning and supporting the digital literacy of pupils. A key challenge identified was supporting the self-regulated learning of pupils during online teaching and preventing feelings of isolation from pupils. Technological challenges were also identified as a barrier to implementing online components of blended learning.

How does the approach impact pupils from disadvantaged backgrounds?

While none of the reviews directly explored the impact of blended learning on disadvantaged pupils, many of the challenges identified in the Rasheed et al review might be considered particular barriers to the learning of disadvantaged pupils. Ensuring access to technology and reliable internet access is crucial to blended learning approaches.

Relevant EEF-funded evaluations

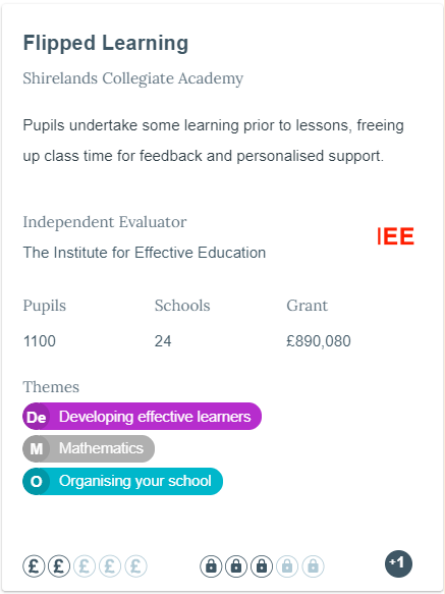
The EEF funded an evaluation of a project called 'Flipped Learning', in which pupils learned core content online and then used class time for activities to re-enforce learning.

In the study, pupils accessed a learning platform where they could access resources uploaded by teachers communicate with other members of the class. Teachers also had access to a resource bank based on the learning objectives for mathematics according to the national curriculum

The evaluation found a small positive impact on Key Stage 2 maths outcomes. The outcome was larger for pupils eligible for free school meals.

An important finding from the study was that some pupils were unable to engage with the online component of the project due to not having access to the internet at home. In this project, pupils were given access to internet through homework clubs that took place in school. In situations where access to school is not possible, practitioners need to think carefully about how to either provide access to the internet to all pupils or to provide teaching through offline means.

The full evaluation report of 'Flipped Learning' can be found **here**.



Computer-supported collaborative learning

The approach

In computer-supported collaborative learning (CSCL) approaches, learning takes place through social interaction using either a computer or the internet. Collaboration may occur using video, chat, emails, discussion boards or knowledge forums. These approaches can take place in the classroom or over the internet. Approaches often use specific tools for co-construction of work – for example, shared workspaces like Google Docs or Slack. Approaches in which pupils interact over the internet while working at home might be relevant during school closures.

Findings and implications

- Providing elements of collaborative learning within online learning environments appears to be linked to positive impacts on learning outcomes.
- The impact of computer-supported collaborative learning has mainly been reviewed in STEM subjects and language learning.
- There is some evidence that shared online workspaces like Google Docs can support learning, particularly for older pupils. However, it is likely that pupils will require on-going support to use them effectively.

Relevant studies

Review	Review focus	Number of studies	Reported impact
Chen et al (2018)	This review examines the impact of collaborative learning in computer environments. The headline impact compares CSCL with independent computer use.	84	0.420
Chen et al. (2019)	This review is an extension of Chen et al (2018) which adds extra moderator analysis. All other aspects of the review are the same.	84	N/A
Jeong et al. (2019)	This review examines the impact of CSCL in STEM subjects.	143	0.490
Lin Huifen;(2014)	This review examines CSCL for second language learning – primarily examining directly communicating in a second language online.	59	0.441
Wecker and Fischer (2014)	This review does not compare CSCL with traditional teaching, but instead compares the impact of using argumentation or not within CSCL environments.	12	0.000

How secure is the evidence?

There are several recent meta-analyses looking at the impact of computer supported collaborative learning. The key challenge of this evidence base is that it is not always made clear when computer-supported collaborative learning (CSCL) interventions are taking place online or in school environments.

Another challenge when interpreting these reviews is that several of them examine specific subjects, interventions or comparisons, so caution should be applied when transferring these findings to other contexts. For example, Lin (2014) examines the impact of online communication in second language learning. The oral focus of second language outcomes may mean that online communication is particularly suited to language learning in a way that does not easily transfer to other subjects. Wecker and Fischer (2014) examine the impact of argumentation within CSCL environments. This means that the reported effect size is not a measure of CSCL overall, as comparison pupils were receiving CSCL without elements of argumentation.

The most general overview of CSCL is provided by Chen et al. (2018). This study is not limited to school-aged pupils, and while moderator analysis found no difference in outcome between school-aged pupils and older learners, it is important to remember that analysis of different CSCL approaches within the review will contain learners from different populations. The main comparison reported by Chen et al (2018) is between collaborative learning in computer environments and independent learning in computer environments and so should not be interpreted as the impact of CSCL in comparison to traditional teaching.

We also appraised the quality of each included systematic review and meta-analysis. It was rare for the included reviews to appraise the quality or risk of bias of the included studies, a limitation of this body of evidence. We therefore do not have a clear understanding of the quality of the underlying research contributing to our conclusions.

What does the evidence say?

The evidence for computer-supported collaborative learning (CSCL) approaches is consistently positive across the included reviews. Even when just examining school aged pupils Chen et al (2019) found significant positive results when comparing collaborative learning with independent learning using computer-based instruction. One study reported a specific outcome measure for using CSCL as part of distance learning and found that the impacts were positive and of a similar magnitude to overall CSCL outcomes (Jeong et al 2019). Chen et al (2018) also explored the impacts of computer use for collaborative learning and found positive impacts on social interaction and group task performance.

An interesting finding from the reviews is the way CSCL appears to have been used in specific subjects. Chen et al (2019) found that at primary school all of the studies focused on using CSCL for science, maths or language instruction. At secondary level all studies were focused on maths or science. Jeong et al (2019) found that CSCL had positive impacts for STEM subjects, while Huifen (2014) found a positive impact for second language learning.

When studies examined the way peers communicate they found no difference between synchronous or asynchronous communication (Chen et al 2018 and Lin 2014). There were, however, some insights into successful implementation strategies. Chen et al (2018) found that peer assessment and feedback strategies led to positive learning outcomes. They also noted that providing instruction and guidance within the computer platform led to positive outcomes. Jeong et al (2019) explored different types of implementation and their impact on STEM outcomes. The combination of technology was found to be particularly important. For example, video conferencing had a large positive impact when paired with shared online workspaces, for example, Google docs. When video conferencing was only supported by email communication, there was no evidence of impact.

How does the approach impact pupils from disadvantaged backgrounds?

None of the reviews considered the impact of computer-supported collaborative learning (CSCL) approaches on pupils from disadvantaged backgrounds. Future research is required to explore how disadvantage pupils are impacted by CSCL. Schools should carefully monitor the learning outcomes of disadvantaged pupils and remove any barriers that pupils may have to accessing CSCL approaches – for example, lack of required technology.

Computer-assisted instruction

The approach

Computer-assisted instruction (CAI) covers a range of approaches in which pupils receive instruction through digital technology. Some common approaches include computer-based interventions that scaffold practice and intelligent tutoring systems that often give adaptive feedback to learners as they work. Many of these interventions have largely been used within school environments, and many of the reviews covered below summarise results from evaluations that have taken place with teacher support present. In response to Covid-19 many companies are offering digital learning applications or programmes in which pupils learn independently. For this reason, we have chosen to include reviews of CAI approaches in our summary.

Findings and implications

- Many computer-assisted instruction programmes have only been evaluated in school settings with teacher support present and may not be transferable to remote learning.
- The impact of computer-assisted instructions vary widely. However, several reviews identify scaffolding and feedback as components of successful approaches.
- Ensuring that teachers and pupils are provided with support and guidance to use technology is essential, for example if new approaches such as intelligent tutoring systems are being introduced.

Relevant studies

Review	Review focus	Number of studies	Reported impact
Abrami et al. (2019)	The review examined the impact of ABRACADABRA – a balanced approach to early literacy instruction.	17	0.26
Batdi (2015)	This meta-analysis measured the impact of computer based teaching on learners' academic success.	78	1.31
Belland et al. (2017)	This Bayesian meta-analysis measured the within subject impact of computer-based scaffolding approaches. The outcome described is for STEM subjects in primary school.	56	0.74
Belland et at (2017b)	This review measures the impact of computer-based scaffolding on STEM outcomes.	114	0.46
Cheung and Slavin (2013)	This review is a general review of the impact of digital technology. The effect size described is specific to computer assisted instruction.	74	0.16
Chiu (2013)	This meta-analysis summarises the impact of computer mediated instruction for language learning and teaching.	16	0.75
der Kleij et al. (2015)	This meta-analysis focuses specifically on providing feedback in computer-based environments. Multiple outcomes are described – the reported impact is for elaborated feedback vs knowledge of correct results.	40	0.39
Fang et al (2019)	This review measures the impact of the ALEKS intelligent tutoring system.	15	0.10
Gerard et al. (2015)	This paper examined the impact of automated guidance on school-aged pupils' learning outcomes.	41	0.34
Karich et al. (2014)	This meta-analysis measured the impact of learner control within computer assisted instruction.	29	0.05
Kim et al (2018)	This review examined the impact of computer-based scaffolding when applied to problem-based learning.	21	0.39
Kulik and Fletcher (2016)	This meta-analysis measured the impact of intelligent tutoring systems.	50	0.62
Kunkel (2015)	This review measured the impact of instruction provided by an application rather than a teacher or classroom aide.	13	0.14
Ma et al. (2014)	This review measured the impact of intelligent tutoring systems.	107	0.41
Ok et al. (2019)	This review examined computer assisted instruction of maths for students with learning disabilities	20	N/A
Rigney et al. (2020)	This review examined the evidence for Headsprout - a computer assisted instruction programme.	6	N/A
Sandy-Hanson (2006)	This review examined digital technology more generally, the impact summarised is specific to computer-based instruction	13 (for CAI)	0.52
Sharifi et al. (2018)	This review measured the impact of computer assisted instruction on language outcomes.	140	0.50
Slavin et al. (2008)	This review examines approaches to improve reading in primary and middle school generally. The impact described is specific to computer assisted instruction.	8	0.10
Steenbergen-Hu and Cooper (2013)	This meta-analysis measures the impact of intelligent tutoring systems.	26	0.09
Strong et al. (2011)	This meta-analysis summarises the impact of the Fast ForWord programme.	6	-0.26
ter Beek et al. (2018)	This review examines the impact of computer supported scaffolding of reading comprehension	5	N/A
Thomas et al (2013)	This meta-analysis compares the impact of interactive and didactic learning within computer assisted instruction.	40	0.18
Verschaffel et al (2019)	This review examines the use of metacognitive scaffolding in ICT based learning environments.	22	N/A

Weng Pei-Lin et al. (2014)	This meta-analysis measures the impact of computer-assisted instruction for SEND pupils.	8	0.35
What Works Clearinghouse (2009)	Earobics - interactive software providing instruction in early literacy skills.	4	0.49
What Works Clearinghouse (2007)	This report summarises the evidence for the Read Naturally programme.	2	N/a
Williams and Beam (2019)	This review examines the use of technology to teach writing skills.	29	N/A
Xu et al. (2019)	This meta-analysis measures the impact of intelligent tutoring systems.	19	0.60

How secure is the evidence?

One of the challenges of the interpreting the evidence for computer-assisted instruction is the large number of reviews, which focus on a variety of different approaches and have been conducted with different levels of methodological rigour. Many of the reviews of CAI approaches have been published within the last five years, so should capture recent developments in technology.

Perhaps the most important limitation of the evidence for CAI approaches is that most of the evidence comes from classroom settings, in which teachers or classroom assistants are able to support learning. This means that caution should be applied when transferring these findings to distance learning contexts.

Another important limitation of some of the included reviews is they include outcome measures that are very close to the intervention being delivered. This issue is particularly prominent in the examples where CAI approaches have been used to teach vocabulary in second language learning and can lead to very high effect sizes being reported.

We also appraised the quality of each included systematic review and meta-analysis. It was rare for the included reviews to appraise the quality or risk of bias of the included studies, a limitation of this body of evidence. We therefore do not have a clear understanding of the quality of the underlying research contributing to our conclusions.

What does the evidence say?

The overall impact of computer-assisted instruction approaches varies. Reviews report outcomes that range from high (Batdi 2015, Chiu 2013, Kulik and Fletcher 2016) to low or negative (Steenbergen-Hu and Cooper 2013, Strong et al. 2011). These differences may be caused by genuine variation in the efficacy of different CAI approaches as well as variation in the methodology of reviews that examine them. There is, however, clear evidence that CAI approaches have the potential to improve learner outcomes, with many of the reviews finding positive impacts.

Intelligent tutoring systems (ITS) are a popular intervention delivering computer-assisted instruction. ITS aim to deliver personalised instruction or feedback to learners. Several reviews have specifically examined the impact of ITS. Ma et al. (2014) found that ITS are effective at improving learner outcomes, but that the impact is dependent on the comparison condition for the intervention. When compared to whole class teaching, intelligent tutoring systems were found to have a high impact, but when compared to one to one human instruction impacts were negative and non-significant. Xu et. al (2019) found positive results even when compared to human tutoring. Steenbergen-Hu and Cooper (2013) found a much smaller positive effect, concluding that intelligent tutoring systems seem to have comparable or slightly better outcomes than traditional classroom instruction.

Several reviews identify scaffolding and feedback as important ingredients of successful CAI approaches. Scaffolding is identified as leading to positive student outcomes by Gerald et al. (2015), Belland et al. (2015), Belland et al. (2015b) and Kim et al. (2018). Verschaffel et. al (2019) find several studies indicating that specifically metacognitive scaffolding – for example, prompts either from teachers or built into the technology that encourage learners to think about successful strategies for learning or when to request help – is an important component of successful CAI. Kim et al (2018) also found higher impact from metacognitive and strategic scaffolding than conceptual scaffolding. The use of feedback within CAI corroborates the wider evidence on feedback, with elaborated feedback in CAI leading to higher outcomes than simply informing pupils of their results (der Kleij et al. 2015).

Implementation seems particularly important across CAI approaches. Kulik and Fletcher (2013) studied the comparison between strongly and weakly implemented examples of intelligent tutoring systems and found that examples with weak implementation had no positive impact. A characteristic of successful ITS approaches identified in the study was that teachers used ITS to supplement teaching rather than as a direct replacement. If schools decide to introduce new technology during periods of closure, they should consider how to make sure approaches are implemented successfully and supplement existing learning approaches.

Several of the reviews summarise the evidence for specific branded interventions that can be delivered using computers. For example, two What Works Clearinghouse reviews examine the Earobics programme, which had some evidence of promise (What Works Clearinghouse 2009) and Read Naturally (What Works Clearinghouse 2007), which was found to not have enough high quality evidence of impact. Other named interventions include ALEKS – an intelligent

tutoring system that was found to be comparable to usual class teaching (Fang et al. 2020); Headsprout – a computer based reading approach that was found be effective at improving reading comprehension (Rigney et al. 2020); and Fast ForWord an computer-based language intervention that was not found to be effective (Strong et al. 2011). One of the named interventions with the highest impact was ABRACADABRA, a balanced reading approach that can be delivered digitally (Abrami et al. 2019). While all of these interventions can be delivered using computers, it is important to emphasise that these reviews and their results do not reflect the programmes being implemented in the home learning environment and several explicitly use teacher or teaching assistants to support the delivery in current studies.

How does the approach impact pupils from disadvantaged backgrounds?

Belland et al. (2017) found a positive impact for computer-based scaffolding approaches for pupils from low-income backgrounds. This contrasts with Cheung and Slavin who found higher outcomes for schools with high SES, although they acknowledge the possibility that this is a result of sampling error and not a generalisable finding. Kunkel (2015) noted that many of the schools included in studies of CAI had high proportions of pupils from disadvantaged backgrounds.

While the evidence for the impact of CAI on disadvantaged pupils is limited and has mixed outcomes, it is worth nothing that technological access is an especially important barrier to programmes that rely on adaptive feedback being delivered through apps or computers. If this barrier can be overcome, CAI does have the advantage of being able to be targeted at particular groups of pupils that might benefit from additional support.

Relevant EEF-funded evaluations

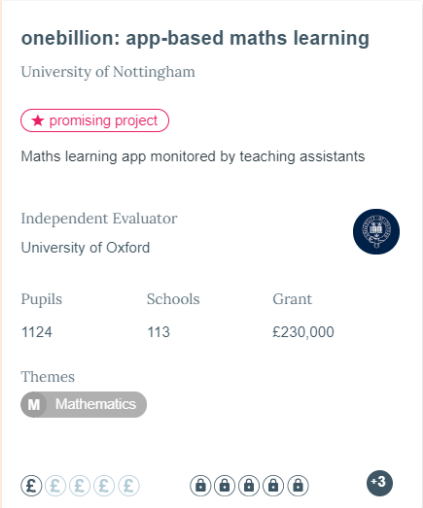
The EEF funded an evaluation of **onebillion** – a maths learning app that is used by pupils in Key Stage 1 to develop early mathematical skills.

In the EEF trial, the app was used as a targeted intervention for small groups of pupils identified as being in the lower half of the class for maths performance. Pupils used the app independently on tablets, while being monitored by teaching assistants.

The independent evaluation found that onebillion had a positive impact on maths learning overall. There was, however, a negative impact on pupils eligible for free school meals – although the number of pupils was not large enough for this finding to be generalisable to all pupils eligible for free school meals.

It is important to highlight that in the EEF trial the intervention took place within school, with teaching assistants monitoring pupils to make sure they were using the app.

The full evaluation report for 'onebillion' can be found **here**.



Another evaluation funded by the EEF tested the impact of **Abracadabra (ABRA)**, one of the specific CAI interventions identified in the reviews.

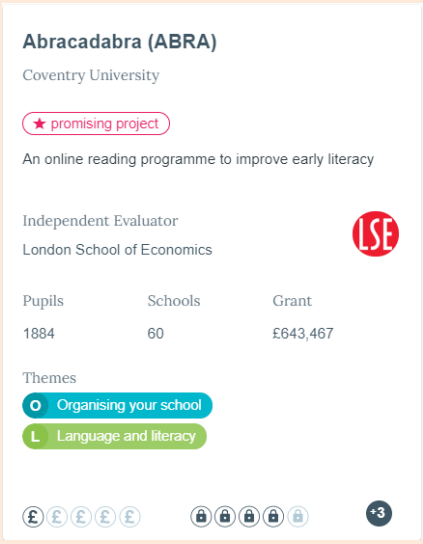
ABRA is an online toolkit of phonics, fluency and comprehension activities aimed at primary school pupils. In the EEF trial, the use of ABRA in school settings was supported by trained teaching assistants. The independent evaluation found a positive impact on Key Stage 1 reading outcomes. Schools that want to use ABRA as a tool for distance learning should consider how they can provide the support pupils need to use the online tools effectively.

The full evaluation report for ABRA can be found **here**.

The EEF has also published independent evaluations of other CAI approaches:

- Accelerated Reader
- Tutoring with Alphie
- Stop and Think: Counterintuitive Concepts

None of the evaluations took place during distance learning.



Games for learning

The approach

Games for learning (GL) are often described as 'serious games' and are designed for educational purposes. They are often played on computers with learning taking place individually. They are contrasted with entertainment games, in which the aim is to provide entertainment rather than improving learning outcomes. While many evaluations of digital games have taken place in classroom settings, the fact that they can be delivered without face to face instruction means that schools may consider using them as part of distance learning provision.

Findings and implications

- Many games for learning have only been evaluated in school settings and may not be well-suited to supporting remote learning.
- There is some evidence that the games that are well-suited to remote learning have particular characteristics, such as providing additional scaffolding or detailed feedback.
- The evidence base is stronger for using games to learn foreign languages. Some studies also highlighted that games involving peer interaction were particularly promising.

Relevant studies

Review	Review focus	Number of studies	Reported impact
Acquah and Katz (2020)	This review examines digital based games learning and L2 language learning.	26	N/A
Boyle et al (2016)	This systematic review examines game-based approaches to learning overall.	143	N/A
Byun and Joung (2018)	This meta-analysis measures the impact of digital game based learning in mathematics.	33	0.370
Chen et al. (2018)	This meta-analysis measures the impact of digital game based learning of vocabulary.	10	1.027
Girard et al. (2013)	This review summarises the evidence for serious games.	11	N/A
Hainey et al. (2016)	This review summarises the evidence for game based learning.	45	N/A
Hussein et al. (2019)	This review summarises the literature of game-based learning on science outcomes for primary school pupils.	17	N/A
Martinez-Garza et al. (2013)	This review summarises the literature of game-based learning on science outcomes	56	N/A
Riopel et al. (2019)	This meta-analysis summarises the impact of serious games on natural sciences outcomes.	79	0.340
Tokac et al. (2019)	This review measures the impact of game-based learning on mathematics outcomes in school-aged pupils.	24	0.130
Tsai and Tsai (2018)	This meta-analysis measures the impact of digital vocabulary learning games on vocabulary outcomes of foreign language students.	26	0.986
Wouters et al. (2013)	This review measures the impact of serious games on motivation and learning. The outcome summarised is for learning.	39	0.290
Wouters and van Oostendorp (2013)	This meta-analysis compares the impact of games that feature instructional support with games that do not.	29	0.330
Zou et al. (2019);	This review examines the evidence for digital game-based learning of vocabulary.	21	N/A

How secure is the evidence?

Many of the included reviews did not calculate the impact of games for learning, and several discuss the lack of high quality evaluations of the approach. As with computer-assisted instruction, many of the reviews either do not make clear what context the games have been evaluated in, or comprise largely of evaluations that take place within school, with support from teachers. This means that findings may not be transferable to remote learning. Also, similar to computer-assisted instruction approaches, several of the reviews focus on language learning and have vocabulary outcomes that may lead to larger effect sizes that do not translate to other subjects.

We also appraised the quality of each included systematic review and meta-analysis. It was rare for the included reviews to appraise the quality or risk of bias of the included studies, a limitation of this body of evidence. We therefore do not have a clear understanding of the quality of the underlying research contributing to our conclusions.

What does the evidence say?

Among the reviews that calculate an overall impact for games for learning, there are a wide range of effects. The two studies with the highest impacts (Tsai and Tsai 2018, Chen et al. 2018) both examine the impact of digital games on foreign language learning. GL may be particularly effective for learning and memorising vocabulary from foreign languages or that vocabulary outcome measures are more likely to produce high results in evaluations of GL approaches. Several of the reviews call for more high-quality evaluation of GL and note mixed results of evaluations that measure standardised learning outcomes (Hainey et al. 2016, Hussein et al. 2019). Despite these limitations, the seven meta-analyses of GL that calculate an average impact do all find the approach to be positive. It does appear that using games for learning has the potential to improve pupil outcomes.

There are some indications that different types of learning games are applicable in different contexts. For example, Tsai and Tsai (2018) found that more sophisticated games had a high impact in informal settings, such as home learning, but did not have an impact when delivered in formal education.

Wouters and van Oostendorp (2013) reviewed the impact of instructional support being provided within games and found a positive impact. Other aspects of games that were found to be linked with positive outcomes were aspects of reflection, modelling, feedback and personalisation. This finding is similar to positive characteristics identified in the reviews of more general computer-assisted instruction. Riopel et al (2019) also found that learner control over content sequence or pace led to positive impacts.

Several of the reviews provided a narrative summary of different evaluations of GL approaches and discussed aspects that had been identified as characteristics of successful games. Boyle et al (2016) identified the value of games that provided rewards and also discussed the importance of usability – for example, games with fast loading times. Aquah and Katz (2020) highlighted the importance of games being easy to use, providing instant feedback and having a clearly defined goal. They also highlighted the benefits of allowing player interaction. An important limitation pointed out by the review is that games being engaging didn't seem to correlate with positive learning outcomes – it is possible to make games that are entertaining but do not provide learning benefits. It is important to note that many of the insights from these narrative summaries are based on a very small number of studies and may not be generalisable.

How does the approach impact pupils from disadvantaged backgrounds?

No reviews systematically examine the impact on pupils from disadvantaged backgrounds. One review (Martinez-Garza et al. 2013) highlighted an example of a hand-held maths game that boosted the learning of disadvantaged first and second grade students in the USA. Another review highlighted a study in which encouraging competition between students had an impact on attainment gaps within the class – although this focused on the gap between high- and low-attaining pupils rather than gaps based on the socio-economic status of pupils. Hussein et al. (2019) identify technological capacity as a barrier to implemented GL approaches.

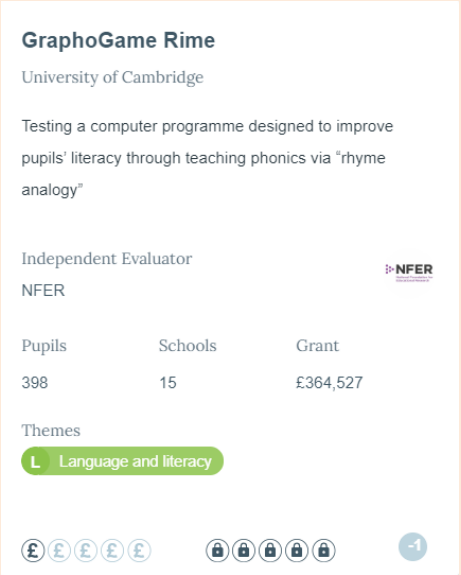
Relevant EEF-funded evaluations

The EEF has funded one evaluation of a game for learning approach, '**GraphoGame Rime'**. This is a computer game designed to teach pupils to read by developing their phonological awareness and phonics skills. Pupils access the game on individual devices.

The independent evaluation did not find a positive impact for pupils identified as having low skills by the phonics screening test in Key Stage 1. Pupils in comparison schools did receive additional support, including small group and one to one activities. Teachers found the programme easy to implement and considered it highly engaging.

This EEF trial took place in a school setting, in which learners were supervised by teachers or teaching assistants while using GraphoGame Rime. If schools are going to use the programme for remote learning, it is important to consider how support will be put in place for learners.

The full evaluation report for 'GraphoGame Rime' can be found **here**.



Meta-analyses and systematic reviews included in the rapid evidence assessment

Full list of included reviews

Title	Author	Year	Intervention type	Age	Pooled effect	Outcome
Digital game-based L2 learning outcomes for primary through high-school students: A systematic literature review	Acquah Emmanuel O; Katz Heidi T;	2020	Education games	School aged	N/A	N/A
The effects of ABRACADABRA on reading outcomes: An updated meta-analysis and landscape review of applied field research	Abrami Philip ; Borokhovski Eugene ; Lysenko Larysa ;	2019	Computer assisted instruction	Ages 3-9	0.263	Phonics (adjusted)
A Meta-Analytic Study Concerning the Effect of Computer-Based Teaching on Academic Success in Turkey	Batdi Veli ;	2015	Computer assisted instruction	All (from school to adult)	1.310	Academic success in secondary school
A Bayesian Network Meta-Analysis to Synthesize the Influence of Contexts of Scaffolding Use on Cognitive Outcomes in STEM Education	Belland Brian R; Walker Andrew E; Kim Nam Ju;	2017	Computer assisted instruction	All (from school to adult)	0.740	STEM outcomes for elementary school
Synthesizing Results From Empirical Research on Computer-Based Scaffolding in STEM Education: A Meta-Analysis	Belland Brian R; Walker Andrew E; Kim Nam Ju; Lefler Mason ;	2017	Computer assisted instruction	All (from school to adult)	0.460	STEM outcomes
A Meta-Analysis of Three Types of Interaction Treatments in Distance Education	Bernard Robert M; Abrami Philip C; Borokhovski Eugene ; Wade C Anne; Tamim Rana M; Surkes Michael A; Bethel Edward Clement;	2009	Remote learning	All (from school to adult)	0.380	Attainment
Are contextual and designed student-student interaction treatments equally effective in distance education?	Borokhovski Eugene ; Tamim Rana ; Bernard Robert M; Abrami Philip C; Sokolovskaya Anna ;	2012	Remote learning	All (from school to adult)	0.310	Attainment
An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games	Boyle Elizabeth A; Hainey Thomas ; Connolly Thomas M; Gray Grant ; Earp Jeffrey ; Ott Michela ; Lim Theodore ; Ninaus Manuel ; Ribeiro Claudia ; Pereira Joao ;	2016	Education games	All (from school to adult)	N/A	N/A
Digital game-based learning for K-12 mathematics education: A meta-analysis	Byun JaeHwan ; Joung Eunmi ;	2018	Education games	School aged	0.370	Unclear
A meta-analysis of the impact of technology on learning effectiveness of elementary students	Chauhan Sumedha ;	2017	Remote learning	Primary school	0.700	Learning outcomes in non-formal environments
The Role of Collaboration, Computer Use, Learning Environments, and Supporting Strategies in CSCL: A Meta-Analysis	Chen Juanjuan ; Wang Minhong ; Kirschner Paul A; Tsai Chin-Chung ;	2018	Computer supported collaborative learning	All (from school to adult)	0.420	Knowledge
A meta-analysis examining the moderating effects of educational level and subject area on CSCL effectiveness	Chen Juanjuan ; Wang Minhong ; Kirschner Paul A; Tsai Chin-Chung ;	2019	Computer supported collaborative learning	All (from school to adult)	N/A	N/A
The effectiveness of digital game-based vocabulary learning: A framework-based view of meta-analysis	Chen Meng-Hua ; Tseng Wen-Ta ; Hsiao Tsung-Yuan ;	2018	Education games	All (from school to adult)	1.027	Vocabulary
The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis	Cheung Alan C K; Slavin Robert E;	2013	Computer assisted instruction	School aged	0.160	Standardised tests in mathematics

Computer-Assisted Second Language Vocabulary Instruction: A Meta-Analysis	Chiu Yi-Hui ;	2013	Computer assisted instruction	All (from school to adult)	0.745	Vocabulary
A Meta-analysis of the Peer Evaluation Effects on Learning Achievements in Blended Learning Environment	Cui Panpan ; Zheng Lanqin ;	2018	Blended learning	All (from school to adult)	0.675	Learning achievement
Effectiveness of online discussion strategies: A meta-analysis	Darabi Aubteen ; Liang Xinya ; Suryavanshi Rinki ; Yurekli Hulya ;	2013	Remote learning	All (from school to adult)	0.499	Learning outcomes
Effects of Feedback in a Computer-Based Learning Environment on Students' Learning Outcomes: A Meta-Analysis	der Kleij ; Fabienne M ; Feskens Remco C W; Eggen Theo J H M;	2015	Computer assisted instruction	All (from school to adult)	0.39 (elaborated feedback vs knowledge of correct results)	Learning outcomes
A meta-analysis of the effectiveness of ALEKS on learning	Fang Ying ; Ren Zhihong ; Hu Xiangen ; Graesser Arthur C;	2019	Computer assisted instruction	Secondary and post-secondary	0.100	Maths learning outcomes
Automated, adaptive guidance for K-12 education	Gerard Libby ; Matuk Camillia ; McElhaney Kevin ; Linn Marcia C;	2015	Computer assisted instruction	School aged	0.340	Learning outcomes
Serious games as new educational tools: how effective are they? A meta-analysis of recent studies	Girard C ; Ecalle J ; Magnan A ;	2013	Education games	Unclear	N/A	N/A
A systematic literature review of games-based learning empirical evidence in primary education	Hainey Thomas ; Connolly Thomas M; Boyle Elizabeth A; Wilson Amanda ; Razak Aisya ;	2016	Education games	Primary school	N/A	N/A
Effects of Digital Game-Based Learning on Elementary Science Learning: A Systematic Review	Hussein Mahmood H; Ow Stew Hock; Cheong Loh Sau; Thong Meow-Keong ; Ebrahim Nader Ale;	2019	Education games	Primary school	N/A	N/A
Ten years of Computer-Supported Collaborative Learning: A meta-analysis of CSCL in STEM education during 2005-2014	Jeong Heisawn ; Hmelo-Silver Cindy E; Jo Kihyun ;	2019	Computer supported collaborative learning	All (from school to adult)	0.490	STEM outcomes
1:1 online tuition: a review of the literature from a pedagogical perspective	Jopling M ;	2012	Remote learning	All (from school to adult)	N/A	N/A
Updated Meta-Analysis of Learner Control Within Educational Technology	Karich Abbey C; Burns Matthew K; Maki Kathrin E;	2014	Computer assisted instruction	All (from school to adult)	0.050	Mixture of academic and behaviour
Effectiveness of Computer-Based Scaffolding in the Context of Problem-Based Learning for Stem Education: Bayesian Meta-analysis	Kim Nam Ju; Belland Brian R; Walker Andrew E;	2018	Computer assisted instruction	All (from school to adult)	0.385	STEM outcomes
Effectiveness of Intelligent Tutoring Systems: A Meta-Analytic Review	Kulik James A; Fletcher J D;	2016	Computer assisted instruction	All (from school to adult)	0.620	Learning outcomes
The Effects of Computer-Assisted Instruction in Reading: A Meta-Analysis	Kunkel Amy ;	2015	Computer assisted instruction	School aged	0.140	Reading outcomes
Establishing an empirical link between computer-mediated communication (CMC) and SLA: A meta-analysis of the research	Lin Huifen ;	2014	Computer supported collaborative learning	All (from school to adult)	0.441	Language learning
Intelligent Tutoring Systems and Learning Outcomes: A Meta-Analysis	Ma Wenting ; Adesope Olusola O; Nesbit John C; Liu Qing ;	2014	Computer assisted instruction	All (from school to adult)	0.410	Learning outcomes
Digital games and the US National Research Council's science proficiency goals	Martinez-Garza Mario ; Clark Douglas B; Nelson Brian C;	2013	Education games	All (from school to adult)	N/A	N/A
The Effectiveness of Online and Blended Learning: A Meta-Analysis of the Empirical Literature	Means Barbara ; Toyama Yukie ; Murphy Robert ; Baki Marianne ;	2013	Remote learning/Blended learning	All (from school to adult)	0.200	Learning outcomes
Evaluation of Evidence-Based Practices in Online Learning	Means Barbara ; Toyama Yukie ; Murphy Robert ; Bakia Marianne ; Jones Karla ;	2009	Remote learning/Blended learning	All (from school to adult)	0.240	Learning outcomes
Effects of Computer-Assisted Instruction on the Mathematics Performance of Students with Learning Disabilities: A Synthesis of the Research	Ok Min Wook; Bryant Diane Pedrotty; Bryant Brian R;	2019	Computer assisted instruction	School aged	N/A	N/A
A Spotlight on Lack of Evidence Supporting the Integration of Blended Learning in K-12 Education: A Systematic Review	Poirier Mark ; Law Jeremy M; Veispak Anneli ;	2019	Blended learning	School aged	N/A	N/A

Challenges in the online component of blended learning: A systematic review	Rasheed Rasheed Abubakar; Kamsin Amirrudin ; Abdullah Nor Aniza;	2020	Blended learning	Unclear	N/A	N/A
Headsprout: A Systematic Review of the Evidence	Rigney Alexander M; Hixson Michael D; Drevon Daniel D;	2020	Computer assisted instruction	School aged	N/A	N/A
Impact of serious games on science learning achievement compared with more conventional instruction: an overview and a meta-analysis	Riopel Martin ; Nenciovici Lucian ; Potvin Patrice ; Chastenay Pierre ; Charland Patrick ; Sarrasin Jeremie Blanchette; Masson Steve ;	2019	Education games	All (from school to adult)	0.340	Declarative knowledge
A meta-analysis of the impact of computer technology versus traditional instruction on students in kindergarten through twelfth grade in the United States: A comparison of academic achievement, higher -order thinking skills, motivation, physical outcomes and social skills	Sandy-Hanson Anika E;	2006	Computer assisted instruction	School aged	0.26 (distance education effect size taken)	Academic outcomes
Retrospect and prospect of computer assisted English language learning: a meta-analysis of the empirical literature	Sharifi Maryam ; AbuSaeedi AliAsghar Rostami; Jafarigohar Manoochehr ; Zandi Bahman ;	2018	Computer assisted instruction	All (from school to adult)	0.500	L2 learning outcomes
Effective reading programs for middle and high schools: A best-evidence synthesis	Slavin Robert E; Cheung Alan ; Groff Cynthia ; Lake Cynthia ;	2008	Computer assisted instruction	Middle and high school	0.100	Reading outcomes for CAI
A Meta-Analysis of the Effectiveness of Intelligent Tutoring Systems on K-12 Students' Mathematical Learning	Steenbergen-Hu Saiying ; Cooper Harris ;	2013	Computer assisted instruction	School aged	0.090	Maths learning outcomes
A Systematic Meta-Analytic Review of Evidence for the Effectiveness of the "Fast ForWord" Language Intervention Program	Strong Gemma K; Torgerson Carole J; Torgerson David ; Hulme Charles ;	2011	Computer assisted instruction	School aged	-0.260	Reading (pooled)
Supporting Secondary School Students' Reading Comprehension in Computer Environments: A Systematic Review	ter Beek ; Marlies ; Brummer Leonie ; Donker Anouk S; Opdenakker Marie-Christine J L;	2018	Computer assisted instruction	Secondary school	N/A	N/A
The differential effects of interactive versus didactic pedagogy using computer-assisted instruction	Thomas Tieja ; Alexander Kristopher ; Jackson Renee ; Abrami Philip C;	2013	Computer assisted instruction	All (from school to adult)	0.175	Learning outcomes
Effects of game-based learning on students' mathematics achievement: A meta-analysis	Tokac Umit ; Novak Elena ; Thompson Christopher G;	2019	Education games	School aged	0.130	Maths learning outcomes
Digital game-based second-language vocabulary learning and conditions of research designs: A meta-analysis study	Tsai Yu-Ling ; Tsai Chin-Chung ;	2018	Education games	All (from school to adult)	0.986	Vocabulary
Online Writing Instruction for Children with Disabilities: A Review of the Empirical Literature	Vasquez III ; Eleazar ; Straub Carrie ;	2016	Remote learning	School aged	N/A	N/A
Learning Mathematics in Metacognitively Oriented ICT-Based Learning Environments: A Systematic Review of the Literature	Verschaffel Lieven ; Depaepe Fien ; Mevarech Zemira ;	2019	Computer assisted instruction	School aged	N/A	N/A
Where is the evidence? A meta-analysis on the role of argumentation for the acquisition of domain-specific knowledge in computer-supported collaborative learning	Wecker Christof ; Fischer Frank ;	2014	Computer supported collaborative learning	Unclear	0.000	Domain specific knowledge
Effectiveness of Cognitive Skills-Based Computer-Assisted Instruction for Students With Disabilities A Synthesis	Weng Pei-Lin ; Maeda Yukiko ; Bouck Emily C;	2014	Computer assisted instruction	School aged	0.350	Cognitive learning outcomes
Earobics[R]. What Works Clearinghouse Intervention Report	What Works Clearinghouse	2009	Computer assisted instruction	Primary school	0.490	Alphabetics
Read Naturally. What Works Clearinghouse Intervention Report	What Works Clearinghouse	2007	Computer assisted instruction	Primary school	N/a	N/a
Technology and writing: Review of research	Williams Cheri ; Beam Sandra ;	2019	Computer assisted instruction	School aged	N/A	N/A
A Meta-Analysis of the Cognitive and Motivational Effects of Serious Games	Wouters Pieter ; van Nimwegen ; Christof ; van Oostendorp ; Herre ; van der Spek ; Erik D ;	2013	Education games	All (from school to adult)	0.290	Learning

A meta-analytic review of the role of instructional support in game-based learning	Wouters Pieter ; van Oostendorp ; Herre ;	2013	Education games	All (from school to adult)	0.330	Knowledge
The effectiveness of intelligent tutoring systems on K-12 students' reading comprehension: A meta-analysis	Xu Zhihong ; Wijekumar Kausalai Kay; Ramirez Gilbert ; Hu Xueyan ; Irey Robin ;	2019	Computer assisted instruction	School aged	0.600	Reading comprehension
What makes the difference? A practical analysis of research on the effectiveness of distance education	Zhao Y ; Lei J ; Yan B ; Lai C ; Tan H S;	2005	Remote learning	All (from school to adult)	0.100	Learner outcomes
Digital game-based vocabulary learning: where are we and where are we going?	Zou Di ; Huang Yan ; Xie Haoran ;	2019	Education games	Unclear	N/A	N/A

Note: where available the outcomes use the description provided by the authors. Terms such as “academic attainment” or “learner outcomes” may be equivalent.

Conclusion

Key findings and implications

1. **Teaching quality is more important than how lessons are delivered**

Pupils can learn through remote teaching.

Ensuring the elements of effective teaching are present – for example clear explanations, scaffolding and feedback – is more important than how or when they are provided. There was no clear difference between teaching in real time ("synchronous teaching") and alternatives ("asynchronous teaching").

For example, teachers might explain a new idea live or in a pre-recorded video. But what matters most is whether the explanation builds clearly on pupils' prior learning or how pupils' understanding is subsequently assessed.

2. **Ensuring access to technology is key, particularly for disadvantaged pupils**

Almost all remote learning uses digital technology, typically requiring access to both computers and the internet.

Many reviews identify lack of technology as a barrier to successful remote instruction. It is important that support is provided to ensure that disadvantaged pupils – who are more likely to face these barriers – have access to technology.

In addition to providing access to technology, ensuring that teachers and pupils are provided with support and guidance to use specific platforms is essential, particularly if new forms of technology are being implemented.

3. **Peer interactions can provide motivation and improve learning outcomes**

Multiple reviews highlight the importance of peer interaction during remote learning, as a way to motivate pupils and improve outcomes.

Across the studies reviewed, a range of strategies to support peer interaction were explored, including peer marking and feedback, sharing models of good work, and opportunities for live discussions of content.

The value of collaborative approaches was emphasised in many reviews, although notably many studies involved older learners. Different approaches to peer interaction are likely to be better suited to different age groups.

4. **Supporting pupils to work independently can improve learning outcomes**

Pupils learning at home will often need to work independently. Multiple reviews identify the value of strategies that help pupils work independently with success.

For example, prompting pupils to reflect on their work or to consider the strategies they will use if they get stuck have been highlighted as valuable.

Wider evidence related to metacognition and self-regulation suggests that disadvantaged pupils are likely to particularly benefit from explicit support to help them work independently, for example, by providing checklists or daily plans.

5. **Different approaches to remote learning suit different tasks and types of content**

Approaches to remote learning vary widely and have different strengths and weaknesses. Teachers should be supported to consider which approaches are best suited to the content they are teaching and the age of their pupils.

For example, games for learning were found to have a high impact on vocabulary learning in foreign languages, but there is less evidence related to their use in other subjects.

Likewise, using technology to support retrieval practice and self-quizzing can help pupils retain key ideas and knowledge, but is not a replacement for other forms of assessment.

The evidence in this review is drawn from diverse contexts that do not closely parallel the circumstances facing schools responding to Covid-19 in 2020. Many forms of digital technology could in theory be used to support remote learning, but are typically used in schools and have not been evaluated as remote learning tools. In all cases, it is important for teachers and school leaders to use their professional judgement in determining the support they provide their pupils and to monitor its impact on learning.

Research questions

The systematic search retrieved 60 systematic reviews and meta-analyses.

1. How effective are distance learning and online learning approaches in comparison to usual schooling?

There is evidence that remote learning can have positive impacts on learner outcomes – most meta-analyses conducted on remote learning approaches found results to be either higher or the same as traditional instruction. The evidence, however, is spread across a wide range of different interventions, subjects and study designs.

This review does not attempt to measure the impact of distance learning overall, but instead summarises the impact of different reviews and approaches thematically.

2. Does pupil or school level disadvantage moderate pupil achievement outcomes in distance learning approaches?

Very few studies examined the impact of remote learning approaches on disadvantaged pupils. More research is needed to see if remote learning approaches widen the attainment gap. Several studies do identify access to technology as an important barrier to implementing remote learning approaches. If school or pupil level disadvantage means that pupils do not have access to the technology needed to engage with remote learning, this is likely to cause attainment gaps to widen.

3. How do different distance learning approaches moderate pupil achievement outcomes?

The methodological limitations of this review of existing systematic reviews and meta-analyses means that it is not possible to systematically examine differential impacts of different approaches. There are several trends within the reviews in which research teams have highlighted particularly promising approaches, or conducted moderator analysis that indicate differential effects.

- Across multiple approaches and reviews, aspects of collaborative learning or peer to peer interaction are identified as leading to improved pupil outcomes.
- Scaffolding, feedback and opportunities to reflect on learning are highlighted as promising aspects of remote learning, across a variety of approaches.
- Computer assisted instruction and games for learning have some evidence of promise when examined as general approaches but are lacking in high quality evidence when applied to remote learning.

4. What are the characteristics of effective distance learning implementation?

Studies that examined specific differences in distance learning implementation found limited results. Evidence was mixed and inconclusive between synchronous, asynchronous or mixed instruction. There was no evidence that any one medium or delivery mechanism was particularly successful at improving pupil outcomes. There was evidence that quality of implementation did impact learning outcomes and that this might include providing professional support for practitioners delivering remote instruction.

5. Which EEF-funded programmes that could be or have been delivered remotely have shown promise in terms of improving pupil achievement, compared to business as usual?

No EEF-funded programmes have been delivered in genuine remote learning conditions. There are, however, several projects that might be possible to deliver remotely, with adaptation. For example, projects like ABRA have the capability to be delivered remotely due to supporting independent work and delivering content through the internet. However, in the EEF trial of ABRA, teaching assistants played an active role in supporting the learners.

The results of less promising programmes may also not be directly transferable to remote learning, as when evaluated by the EEF the comparison condition was often high quality usual practice in schools. For example, GraphoGame Rime was not found to have an impact on early reading outcomes, but the comparison group were pupils identified with low levels of reading, who were receiving extensive support through other interventions such as small group tuition.

In times of school closure, programmes that had less promising results may lead to positive outcomes in comparison with alternatives in remote provision. This might particularly be the case for disadvantaged pupils or pupils with low prior attainment who may have been receiving additional support in normal school conditions.

Limitations

This review has been limited by a number of factors.

Umbrella review methodology

In order to complete this review quickly and to respond to schools need for evidence on remote learning, this review was limited to existing systematic reviews and meta-analyses. This means that we are unable to perform moderator analysis on specific types of remote learning and cannot apply quality criteria to individual studies. The limitations of this methodology mean that we have not provided an overall estimate of impact for remote learning, or for any of the specific approaches through which distance learning may be delivered.

Limitations in the evidence-base on distance learning

Many of the reviews failed to find evidence that related to school-aged learners receiving remote teaching. Many reviews that included studies from schools also included studies on higher education and these were usually greater in number. In these combined reviews, it was often unclear in moderator analysis how many studies from school-aged pupils featured in the analysis. Other approaches, such as computer assisted instruction or learning games had much more school-aged evidence, but evaluations rarely took place during periods of remote learning. Careful consideration about the extent to which the evidence from higher education remote learning studies and school-aged non-remote learning studies can be applied to the current circumstances.

Quality of review methods within education

One of the interesting findings of the review was the low quality of review methods amongst the retrieved studies. We rated the quality of each of the reviews using a number of criteria (the full rating system is available in the protocol **here**). Almost none of the studies applied any kind of risk of bias assessment for the included studies. This meant that 45 of the 60 reviews were rated as “low” in the quality assessment. While some reviews did explore methodological causes for heterogeneity – for example, sample size or type of measure – the fact that almost no studies assessed the quality of the individual studies included in the reviews is a severe limitation to the quality of the reviews summarised in this rapid evidence assessment.

Future research

A technical write up of the rapid evidence assessment will be published in the future.

Additional resources

The Education Endowment Foundation has created a number of resources that are relevant to supporting learners during the Covid-19 outbreak. All resources can be found **here**. Some of the resources that directly relate to the findings of the remote learning rapid evidence assessment are detailed below:

Resource	Description	Link
Guidance reports	EEF guidance reports provide clear and actionable recommendations for teachers on a range of high-priority issues based on the best available evidence.	**https://educationendowmentfoundation.org.uk/tools/guidance-reports/**
Parental engagement guidance report	Four recommendations on working with parents to support their child's learning.	**https://educationendowmentfoundation.org.uk/tools/guidance-reports/working-with-parents-to-support-childrens-learning/**
Parental engagement evidence review	The underlying evidence review for the parental engagement guidance report.	**https://educationendowmentfoundation.org.uk/evidence-summaries/evidence-reviews/parental-engagement/**
Digital technology guidance report	Four recommendations on using digital technology to improve children's learning.	**https://educationendowmentfoundation.org.uk/tools/guidance-reports/using-digital-technology-to-improve-learning/**
Digital technology evidence review	The underlying evidence review for the digital technology guidance report.	**https://educationendowmentfoundation.org.uk/evidence-summaries/evidence-reviews/digital-technology-2019/**
Metacognition guidance report	Seven recommendations for teaching self-regulated learning and metacognition,	**https://educationendowmentfoundation.org.uk/tools/guidance-reports/metacognition-and-self-regulated-learning/**
Teaching and Learning Toolkit	The Teaching and Learning Toolkit provides an accessible summary of the evidence across 35 different approaches aimed at improving pupil outcomes	**https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/**
Peer tutoring	Toolkit summary of peer tutoring approaches	**https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/peer-tutoring/**
Metacognition and self-regulation	Toolkit summary of metacognition and self-regulation approaches	**https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/meta-cognition-and-self-regulation/**
Parental engagement	Toolkit summary of parental engagement approaches	**https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/parental-engagement/**
Homework	Toolkit summary of homework (primary and secondary)	**https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/homework-primary/** **https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/homework-secondary/**
Digital technology	Toolkit summary of digital technology approaches	**https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/digital-technology/**
EEF funded evaluations	This is the full list of evaluations that have been funded by the EEF.	**https://educationendowmentfoundation.org.uk/projects-and-evaluation/projects/**
What Works Clearinghouse list of studies	A list of studies that examine the impact of remote learning approaches, identified by the What Works Clearinghouse	**https://ies.ed.gov/ncee/wwc/distancelearningstudy**

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