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A systematic review of the impact of technology-mediated parental engagement on student outcomes

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Abstract

There is considerable evidence that the level of parental involvement is closely associated with children's school outcomes. Schools are increasingly using digital technology to engage parents but the impact of such technology on students' learning behaviour is still unclear. This paper reviews and synthesises international evidence from 29 studies to establish whether technology-mediated parental engagement can improve student outcomes. While the review suggests promising evidence in school-parent communication via phone, texts or emails on children's attainment, attendance and homework completion, such communications have to be two-way, personalised and positive. The evidence for home computers and other portable devices is inconclusive. There is no evidence so far that online technological devices and digital media are effective for improving school outcomes. Current research on the use of such technology is weak. Research in this field needs to consider a more careful and scientific approach to improve the evidence base.

Keywords: parental engagement, digital technology, pupil outcomes, teacher workload

Introduction

Parental involvement

Narrowing the attainment gap between children from disadvantaged backgrounds and their peers has been an education priority for successive governments in the UK, and for other developed countries. Substantial investments have been made in education to improve children's learning and wider outcomes. However, despite numerous policies and initiatives by policy-makers and in schools to raise the attainment of the poorest children, notable attainment gaps between children from disadvantaged homes and those from more well-to-do families persist in the UK. One possible explanation, proposed by some commentators and taken up enthusiastically by governments, lies in the differential involvement of parents. In 2003, the UK new Labour Government published the Green Paper "Every Child Matters" (HM Treasury, 2003) which highlighted a significant role for parents in children's education. Since 2009, OFSTED (the UK national school inspection body) has placed an emphasis on getting schools to engage with parents, to improve the quality of communication between home and school, and to develop strategies that help parents support their children's learning at home. In the US schools are required by law to implement parental involvement provisions in order to receive certain federal funds, such as No Child Left Behind (NCLB) Act of 2001 (NCLB, 2002).

There is considerable evidence from large-scale studies that there is an association between the level of parental involvement and school outcomes for their children (Cooper et al., 2010, Department for Children, Schools and Families [DCSF], 2008, Desforges, 2003). What is less clear is whether parental involvement/engagement is actually a causal factor in attainment or a characteristic of pupils who also have higher attainment. The key question is whether attainment can be increased solely by improving parental involvement. A review of factors

linking attainment with parents' and pupil's attitude and behaviour by See and Gorard (2015b) identified parental involvement in children's education as an approach that offered promise as a causal contributor to attainment. A subsequent review of causal evidence on enhanced parental engagement that does not involve the use of technology found no conclusive evidence that parental engagement alone can lead to improved student academic outcomes. This is mainly because a large majority of the studies had serious methodological flaws, and the few that reported positive outcomes were generally complex interventions in which parental involvement was only part of a package of measures taken to improve results (See & Gorard, 2015a). Strategies to enhance parental involvement have now increasingly moved to digital format with the advancement in technology.

Educational technology developers have claimed that such technology can also reduce teachers' workload through the automation of repetitive tasks. For example, teachers can send messages or homework content to parents enmasse and generate absence reports for parents automatically. Programmes like Marvelous Me, Easypeasy, Pearson Education and Studybugs all said on their websites that their products could facilitate parental engagement thus reducing teachers' workload. Such programmes are therefore very appealing to schools. Research has consistently pointed to workload as the top reason for teachers' decision to leave their jobs (Higton et al., 2017; Lynch et al., 2016; Cooper-Gibson Research, 2018; Ingersoll & Smith, 2003; Ingersoll & Perda, 2010; Ingersoll & May, 2012). Reducing teacher workload is a major challenge for the government in the UK, US and many developed countries.

Use of EdTech in parental engagement

A major part of government policy efforts to improve educational quality and minimise inequality has been to engage parents in various ways in their children's learning through the use of technology. The UK government has invested around £10 billion in educational technology since 1999. Between 1997 and 2010, the focus shifted from introducing technology in schools to introducing technology at home to make learning transcend the boundaries of the school thus narrowing the achievement gap of disadvantaged children (Stevenson, 2011).

Several tools are being employed to engage parents in the learning process of their children. Some researchers claim that these tools may ease communication between schools and parents through the use of emails, text messages, or learning platforms or may involve parents in the learning process of their children through the use of apps or games. However, there is still no clear evidence whether any of those practices can lead to better outcomes in children's learning and attainment as many studies (Baydar et al., 2008; Davidovitch & Yavich, 2015; Ellis, 2008) are based on parents' perception of these tools and not on accurate measures of pupils' progress. Receiving emails and text messages is no guarantee that parents are really getting involved. For example, most platforms are being used as one-way channels of communication to send updates to parents (Selwyn et al., 2011). In a comparative case study of 12 schools in England, Selwyn et al. (2011) draw attention to the fact that those platforms are used in schools only to strengthen existing forms of parental engagement and have not produced a major shift in parent-school communication.

Not all forms of technology-mediated communication between schools and parents are the same. Hollingworth et al. (2009) use the terms "thick" and "thin" communication to refer to the various forms of communication between schools and parents. Many factors affect parental

engagement such as the direction of information flow which can take the form of one-way or two-way communication, the complexity or the simplicity of the message, the extent to which the information is personalised to every student or sent generically to all parents, and the synchronicity of communication (real-time) or delayed communication.

The use of technology at home to engage parents in children's education is particularly nascent in recent times. When a nationwide lockdown was announced in England in March 2020, many schools and parents turned to online teaching to ensure that children continued to be taught during this period. Many parents found themselves more involved in their children's learning. It is too early to tell how such parental engagement will impact on children's learning. In the meantime we can look at existing research for evidence of the successful use of digital technology to engage parents.

Although there is a broad evidence base on how digital technologies (DTs) are being used in schools, there is no clear consensus on how technology should be used effectively to enhance parental engagement. There is also currently no clear evidence yet that the use of technology alone can lead to improvements in learning outcomes (Luckin et al., 2012; Organisation for Economic Co-operation and Development [OECD], 2015; Gorard, See & Morris, 2016; US Department of Education, 2014). This new review summarises the strongest evidence relevant to using education technology (EdTech) to improve parental involvement.

Previous reviews

Few previous reviews have dealt with technology-mediated parental engagement, and those that did are mostly concerned with only specific programmes. Spier et al. (2016), for example,

deals with educational television, and Ewin et al. (2020) mainly focuses on the impact of parent-child engagement with either a smartphone or a tablet. They do not deal with other technological tools. This current review is unusual in that it covers a wide variety of technological tools that engage parents in pupils' education.

Previous reviews also tend to summarise the findings of existing research or average the effect sizes of the individual studies being synthesised, a practice Bob Slavin called, "muddling meta-analysis" (Slavin, 2020a). Such reviews may give misleading conclusions because weak studies often report big effect sizes (See, 2018). Starkey et al. (2018), for example, review studies that measure the educational value of home Internet access, and only provides various classifications of the studies but does not evaluate the strength of the evidence.

Aims

There already exists a large body of research evaluating the use of educational technology in schools, but few focused on the use of educational technology in facilitating parent-school engagement that has beneficial effects on pupil's learning and other wider outcomes. Our new review looks specifically at the use of educational technology in schools that engage parents at home with the potential to reduce teacher workload and improve student outcomes. Accordingly, the aims of this review are to:

- determine whether the use of digital technology in parental engagement can improve young people's outcomes (both cognitive and non-cognitive)
- identify effective digital technology in enhancing parental engagement that also reduces teacher workload
- identify challenges and barriers to the use of digital technology in parental engagement

- identify factors that facilitate the successful use of digital technology in parental engagement

Methods

Search strategy

To identify relevant studies, we systematically searched 14 electronic databases and search engines (see Table 1), Google and Google Scholar. We also followed up references in identified studies and existing reviews of literature as well as work that was known to us from previous work in the field in a daisy-chain manner. The bulk of the material came from the main educational, sociological, psychological databases. To avoid publication bias, we have included both published and unpublished literature (e.g., dissertations/theses).

Insert Table 1 here

Keywords used in the search

The keywords included terms related to educational technology, parental engagement and young people's learning and wider outcomes. As the purpose of this review was to identify approaches that show evidence of impact, the key words also included causal terms (or a synonym) or any research design that would be appropriate for testing a causal model, such as experiments, quasi-experiments, regression discontinuity and difference-in-difference. No date limiter was applied. This was to allow the search to be as broad as possible. The keywords included parents and its synonyms, engagement/participation, technology/ed tech, evaluation, intervention, words relating to experimental/quasi-experimental designs and terms relating to teacher and student outcomes. The full list of the syntax is in the appendix (Appendix 1).

A total of 12,280 research articles were located. Eyeballing of these pieces by titles and abstracts identified 110 apparently relevant ones (Table 2). These were exported to EndNote, a reference manager for screening. Twenty further articles were added from following up references in the identified studies, from previous systematic reviews and from studies known to us. One recently published evaluation from the Education Endowment Foundation (EEF) was added to the list of studies (Robinson-Smith, 2019 et al.,) giving a total of 131 relevant research reports.

Insert Table 2 here

Screening

These research papers were then screened for inclusion by applying the inclusion and exclusion criteria below:

Inclusion criteria:

- Reported in English
- Empirical research
- About the use of digital technology in the school context to engage parents that has an effect on teacher outcomes, e.g., workload
- About the use of technology that has an effect on student academic outcomes (e.g., test scores), and behavioural/affective outcomes (e.g., school attendance, student motivation, attitude and behavior, self-confidence)
- Young people age from pre-school (age 2-5) to age 18
- Mainstream school

Exclusion criteria:

- Duplicates
- Not primary research
- Not published or reported in English
- Higher education context
- Not actually a report of research at all
- Description of the intervention and how it can (theoretically) improve outcomes with no evaluation of outcomes
- Not about the use of educational technology to support parental engagement
- Outcome is not about teacher workload, student learning or other behavioural or affective outcomes
- Not empirical research, e.g., promotional literature, opinion pieces
- Studies that have no clear evaluation of outcomes
- Studies with non-tangible or measurable outcomes
- Ethnographic, opinion pieces, guidance briefs or manuals
- Anecdotal accounts from schools about successful strategies, e.g., case studies of schools
- Related to cultures that are alien to English-speaking countries (e.g., specifically about rural India)
- Related to specific groups of children (e.g., children in special homes, hospitals or children in PRU or Pupil Referral Unit which is a type of school that caters for children who are not able to attend a mainstream school)
- Simply a description of the programme

A sample of 5 were randomly selected and screened by three raters to ensure consistency in applying the inclusion and exclusion criteria. After removing duplicates and applying the inclusion and exclusion criteria 63 studies (out of 131) were retained for data extraction. Sixty-eight were excluded for the following reasons:

- 16 were removed either because they were duplicates or were not relevant to the review topic
- 13 were excluded because they were descriptions of parents' use of EdTech tools
- 1 was excluded because it was not about school's use of EdTech
- 1 was excluded because it became clear that it did not have a comparison group although the author described the study as a quasi-experimental design
- 28 were excluded as they were not impact evaluations, e.g., surveys
- 4 were excluded as the outcomes were not relevant to teacher or student outcomes

These four included one about body-weight management and one about the development of musicianship. These are not academic or behavioural outcomes. Two were removed as they were concerned specifically about engaging parents of children with special educational needs (autism and other physical disabilities)

Data extraction

Studies that met the inclusion criteria relevant to the review question and were research-related were retained and their full reports retrieved for data extraction. This involved extracting information about all aspects of the research design relating to the sampling strategy, the sample size, allocation to groups, the instruments used to assess the outcome measure, and the attrition rate. More studies were excluded at this stage when it was clear that that they were not evaluations of programmes but simple narrative discussion of previous research and

suggestions of strategies. A template for data extraction was designed for use by all reviewers to use to ensure consistency.

Key information extracted included:

- Brief description of the intervention
- Research design:
- Is it a randomised controlled trial
- Is it a quasi-experiment (no randomised allocation to control condition)
- Does it have a control and comparison group
- Does it have pre- and post- event comparisons
- Is it longitudinal, is it a cohort study or combination of some of these
- How is randomisation or other allocation to groups carried out

Sample

- Size of sample
- How are the samples identified and allocated
- School phase, e.g., primary, secondary, post-secondary

Outcome measures

- What are the outcomes and how are they measured

Findings

- Author's results (e.g., positive or no effects)
- Reviewers' analysis of the results (re-calculate effect size if not estimated or if in doubt)

The data extraction also commented on aspects of the study that might threaten or enhance the internal and external validity of the experiment. This could include size of sample, level of dropout, fidelity to treatment, quality of counterfactual, extraneous/confounding variables,

other programmes going on that may have affected the results, misleading use of simple before and after figures and conflicts of interest. Thirty-four were removed after data extraction when it was clear their study designs would not allow for causal claims to be made. Twenty-nine studies were finally retained and quality-assessed. Figure 1 is a flow chart detailing the number of studies at each stage, from identification, screening to data extraction.

Insert Figure 1 here

Assessing the strength of evidence

Each included study was then assessed for its strength of evidence using the "sieve" (Gorard, See & Siddiqui, 2017) based on five criteria (see Table 3).

- Research design and fit to the study research question (e.g., for a causal question, whether it is a randomised control trial (RCT) with random assignment of cases, or matched comparison or longitudinal cohort study).
- Scale of the study (smallest cell size)
- Level of attrition / missing cases or data
- Quality of outcome measurement (e.g., self-report or administrative data, independent or intervention-related assessment)
- Other threats to validity (e.g., contamination, randomisation is subverted, conflict of interest)

While RCTs may be regarded as highly appropriate for evaluating the effectiveness of interventions, they are not immune to problems. The validity of the findings of any randomised control trial can be compromised when randomised groups are diffused such as when the control group inadvertently has access to the programme or when randomisation is subverted, such as when teachers swap children around because they think that certain children would benefit more from the programme. All this can reduce the effects of the trial. In some cases,

the researchers are also the developer of the programme/software, who are likely to have an interest in the success of the trial. These trials tend to report bigger effect sizes (Khan & Gorard, 2012). Therefore, RCTs conducted by intervention developers will reduce the perceived validity of the trial.

Insert Table 3 here

Each study is assigned a score using a padlock system between 1 (the minimum standard to be given any weight, including some kind of comparison) and 4🔒. Four-padlock studies are the most secure, meaning that the evidence is most appropriate for making causal claims. These are studies that use experimental designs, such as randomised control trials, or regression discontinuity designs. Studies must have a comparison group to meet the minimum standard. If not, they will be awarded a zero rating, unless it is a regression discontinuity or time-series analysis where there is a comparison of before and after event in a controlled way. The approach used is described fully in Gorard et al. (2017).

Synthesising evidence

As we sought only the most robust credible evidence, we put great emphasis on the quality of the evidence. Approaches with the most highly rated studies (4-padlocks) showing positive effects are considered the most promising. Unlike most systematic reviews, we do not summarise the aggregated effect sizes as they may give a misleading impression of the efficacy of a programme. Also, a number of studies presented *p*-value and significance but did not provide mean scores to allow for effect size calculation. It is also the case in this review that there are often too few studies for each type of EdTech product that meet our causal criteria. It is therefore not possible to average effect size for each type of programme. As Slavin (2020b)

pointed out, the value of any educational programmes is not determined by its average effects, but rather, by the effectiveness of the best, replicated, and replicable examples (Slavin, 2020b). However, we do report the effect size for individual studies where available (or where there is enough data to calculate the effect size), the direction of the effect (positive, negative or no difference) and the strength of the evidence (i.e., how secure is the finding).

We do not accept the source of any publication or the reputation of its author or funder as any guarantee of research quality. Instead, we judge the credibility of the evidence based on the study design and any threats to the integrity of the research.

Results

A total of 29 studies met our inclusion criteria in terms of relevance to the research topic and the school context. Eighteen of these concerned the use of digital communication, such as phone calls, text messages or websites to support parental engagement. Another five were about the use of home computers and other portable devices such as tablets and iPads. Six were about online technological programmes (homework tools) and digital media (e.g., television programmes and videos).

There were 89 outcomes altogether, as each study may report more than one outcome. The outcomes include parental level of participation, pupils' academic performance and other wider outcomes, such as attendance motivation and attitude. Typically, attainment outcomes are measured using national/state or standardised tests and the wider outcomes are based on participants' self-report. For this reason, the evidence ratings can differ for different outcomes

in the same study. No outcomes were rated as 4🔒, meaning that the overall quality of work in this field is not high, and so any general conclusions drawn cannot be definitive. For the purpose of this report, we discuss only those studies that are rated 2🔒 and above. On occasions, 1🔒 studies may be discussed in conjunction with 2🔒 studies that evaluated similar programmes.

Digital technology with some evidence of promise

Digital communication (Phone and text messages, emails and websites)

Many studies and systematic reviews suggest a positive correlation between parental involvement in children's education and their children's educational outcomes (Epstein & Van Voorhis, 2001; Fan & Chen, 2001, Henderson & Mapp, 2002, See & Gorard, 2015b, Xu et al., 2010). Emails, phone and text messages have now become a standard means of communication between school, teachers and parents (Flowers, 2015), but we do not yet have causal evidence that such communication is effective in enhancing parental involvement and improving children's outcomes. Previous studies have suggested a positive association between parents' satisfaction with the school's ability to communicate information about their child's academic performance and likelihood of participation in college (Griffith, 1996). Some have also argued that voluntary child disclosure produces positive outcomes while close parental monitoring may be damaging (Pathak, 2012). However, these associations do not suggest causality as parents who have better communication with the school may be different to those who do not. (Bergman, 2015). Parents' educational and social background may be factors that could influence the quality of such communications. Parents who monitor their children closely may be doing so because their child is not doing well in school or the other way around. It may also

be the case that children who are doing well are more likely to disclose what they are doing in school.

This new review suggests some promise for home-school engagement using online communication, such as phone and text messages, emails and websites on academic outcomes for both secondary primary school children. The stronger studies (rated 3🔒 for research design and sample size) all suggested that such communications can have a small benefit for maths attainment, but less so for English (Table 4). One highly rated study (Miller et al., 2017) indicates that such communications do not benefit maths for children whose English is not their first language (EAL). See Appendix 2 for a summary of the outcomes and their effects.

There is also some evidence that online communication with parents may help with early years' children's cognitive self-regulation (Robinson-Smith et al., 2019), and may be helpful in reducing absenteeism, but there is no evidence that it helps with other non-academic outcomes such as homework completion (Table 5). The evidence on parental behaviour (e.g., parent-school contact, parental engagement with students' learning) is weak as many of the outcomes are based on parent or teacher self-reports (Table 6). Most of the studies that reported beneficial effects of digital communication on parental outcomes are weak. Only one study rated 2🔒 (Jelley & Sylva, 2018) found positive effects of such communication on parental control.

Insert Tables 4, 5 and 6 here

[2]**Bergman (2015)** conducted a field experiment involving 306 pupils from Grades 6 through 11 (age 8 to 17) in a low-performing school in a deprived area. Parents/guardians were randomly selected to get additional detailed information by emails, text messages and phone calls about their children's missing assignments and their grades several times per month over a period of six months. Positive effects were detected for pupils' high school GPA (Grade Point Average) and California Standards Test (CST) for maths (ES = +0.21) but less so for the CST for English (ES = +0.04). The additional information provided to parents reduced the proportion of pupils not taking final exams or submitting coursework by 7.5 percentage points. Pupil absences decreased by 28%, and parent-teacher conference attendance increased by 53%. Parental contact by teachers increased by 187% relative to control for high school pupils and by 106% for middle school pupils.

A multi-site cluster randomised trial involving 15,697 pupils in Years 7, 9 (age 11-12 and 13-14) and Year 11 (age 15-16) across 36 English secondary schools looked at the Parent Engagement Project (PEP), known as Texting for Parents (**Miller et al., 2017**). This a school-based intervention which sends text messages to parents to inform them about upcoming tests, missing homework, materials learned in school, and attendance summary using the school communications systems. Attainment on English and maths for Years 7 & 9 were measured using the independent Hodder Access tests, and for science the past year KS3 (Key Stage 3) SAT (Standardised Assessment Test) papers were used. Year 11 English and maths attainment results were based on the General Certificate of Secondary Education or GCSE (end of secondary education national exam) results. KS2 (Key Stage 2) results were used to control for prior attainment. Pupils' background, their prior attainment and school characteristics were

[2] Studies in bold are rated 2 🔒 and above, deemed as the best evidence for a causal claim in this review.

used as covariates. Key Stage assessments or SATs are standard assessments at the end of key stages in pupils' school life. These are taken when children are age 7, 11 and 14 (KS1, KS2 and KS3 respectively).

The intervention shows small positive effects on children's maths (ES = +0.07) and English (ES = +0.03), but no effect on science. The intervention was also effective in reducing absenteeism, but only for Year 11 pupils (ES = -0.11). Texting did not benefit the maths outcomes for children with English as an additional language (ES = -0.04). No results were reported for English or science. The study reported an attrition of 19%.

Another randomised control study involving 1,031 families looked at the effects of an early literacy text messaging programme for parents of pre-schoolers (**York & Loeb, 2014**). The programme, known as READY4K!, text messages to parents of four-year olds to support their children's literacy, maths and socio-emotional development. The messages guide parents in daily activities that they can do with their children. Parents were individually randomised to either receive three READY4K! text messages per week or to control group which received one text message every two weeks, about kindergarten enrolment and vaccination. Analyses on 821 (21% attrition) children for whom scores on Phonological Awareness Literacy Screening (PALS) were available suggest positive effect on children's literacy (ES = 0.11). The results also indicate that the programme helps reduce attainment gaps for children who were weaker at baseline, but does not benefit children who were already doing well to begin with. The programme also increased parental engagement in home literacy activities with their children and children's involvement in school.

Three randomised control trials of EasyPeasy, a smartphone app that sends messages to parents of pre-school aged children, suggest positive effects on children's cognitive self-regulation. EasyPeasy is a programme aimed at improving children's development by encouraging active parent-child interaction through play at home. The app sends text messages containing a link to a webpage containing ideas of games for parents to play with their children at home. Parents receive weekly text messages with links to examples of videos games that they can play with their children. There are also tips and advice on how parents can play with their children. The independent evaluation by the Education Endowment Foundation included 102 nurseries, and 1,205 children aged 3 to 4 years (**Robinson-Smith et al., 2019**). There was a small impact on language development (ES = +0.04) and cognitive self-regulation (ES = +0.14). This was a large-scale study and well-conducted, but was rated 3🔒 because randomisation was at the school level, reducing statistical power.

Two other RCTs conducted by Oxford University also show positive effects on cognitive self-regulation. The earlier trial, which lasted 18 weeks, was carried out in 8 childcare centres involving 144 families (Jelley, Sylva & Karemaker, 2016). Games were sent once a week directly to parents' mobiles via an app with prompts, encouragement, reminders and information on child development. Positive effects were found for all the measures but only two of the seven outcomes were statistically significant: cognitive self-regulation (ES = +0.44) and parental consistency in discipline and boundaries (ES = +0.51). This study was rated 1🔒 because of the high rate of attrition (50%) and the fact that the measurements were based on parental self-reports. There is thus the risk of 'social desirability' where parents feel that they have to demonstrate that they were doing well and that their child was making progress.

The second study **(Jelley & Sylva, 2018)** was similar but conducted in 8 childcare centres in another part of England and involved 302 families with children aged 3 to 4. As with the earlier study, positive effects were found for all the measures but only two were statistically significant: cognitive self-regulation (ES = +0.35), and parental control (ES = +0.26). This study was rated 2🔒 simply because the outcomes were all based on parents' self-report.

Five studies were rated 1🔒. These were either correlational studies (Bouffard, 2006) and so were unable to establish the direction of causation or where cases were conveniently randomised from two or three classes (Jordan, 1994; Fitzpatrick, 2013; Radin, 2013) or where the parental outcomes were based on parents' own declaration (Hurwitz et al., 2015).

Bouffard's (2006) study was a longitudinal correlational study which examined the impact of an internet-based parent-school communication. Regression analysis suggests that any usage of internet-based parent-school communication is positively related to children's Grade 12 achievement scores (standardised coefficient= 0.08), parent-child discussion (standardised coefficient= 0.08), and homework involvement (standardised coefficient= 0.1). The use of internet-based communication was also positively correlated with educational expectations (standardised coefficient= 0.15). The frequency of internet-based communication positively predicted children's Grade 12 maths achievement (standardised coefficient= 0.08), but not other outcomes.

Jordan (1994) evaluated the Homework Hotline system, a simplified version of Bauch's Transparent School Model (Bauch 1989), where the school leaves a daily recorded message on the parents' phone answering machine about children's homework assignments and grades.

The study reported a decrease on Grade 5 & 6 children's homework completion rates for language arts, but for maths and social studies for Grade 5 only. Fitzpatrick (2013) evaluated the effects of an online digital communication known as Moodle, an online website where teachers upload videos of maths lessons. These videos were uploaded quarterly along with motivational videos with information on how to encourage students to learn maths. A discussion blog was created where parents can post questions on the website. In addition to the website, teachers also communicated with parents through e-mails each week. The study found no effect on the Tennessee Comprehensive Assessment and a small positive effect on the Discovery Education Assessment (DEA), but no effect on children's maths GPA and maths confidence. There was the issue of diffusion as some parents in the treatment group shared the video with parents in the control group.

Hurwitz et al. (2015) reported higher levels of parental engagement in their children's learning using a text messaging service called Parent University (PU), which sends an age-specific text message a day to parents with suggestions for parent-child activities on a different theme each week for six weeks. Children were between ages 0 and 5. Radin (2013) explored the use of a regular home-school communication system using emails for secondary students. Parents were sent regular bi-weekly emails informing them of homework assignments, upcoming projects and resources for academic and parental support initiated either by the teacher or the students themselves. The study found no effects on parental outcomes.

The other seven studies reported mixed effects of the use of digital communication technology on children's outcomes. They were mainly one group pre-post designs and so were rated zero as they cannot make causal inferences. They are not discussed in detail as they would not

contribute anything of substance to the evidence base. These studies evaluated a range of communication systems, including a voice-messaging service where teachers record a brief message for parents about what was taught, special learning events, homework assignments and other vital information (Bauch, 1994); a parent-teacher communication app (the Bloomz) which is a Facebook-like app which allowed teachers to post calendars, lists and documents (Castaneda, 2019); PowerSchool, an internet-based programme designed to share academic grades online with parents and to increase communication with parents (Ellis 2008), other online communication (Beck, 2013; Davidovitch & Yavich, 2015) and mobile text messaging (Pakter & Chen, 2013). Pakter and Chen's study is interesting in that it found that secondary students whose parents received Zomnimail (text messages) performed worse than those who did not. It also did not increase the attendance of pupils. However, it did reduce the amount of time teachers spent calling parents. One important limitation of Zomnimail, which is worth noting, is that it did not allow parents to reply to text messages, thus limiting two-way communications between parents and school.

In summary, there is some promise that the use of mobile phone apps in providing parents with regular updates on their children's school performance and homework requirements can improve children's academic attainment although the effects are very small. All of the stronger studies (rated 3🔒) suggest that it is effective only for maths but not for English. It also suggests that digital communication has the potential to improve school attendance and reduce absenteeism for older children. Such digital communications may benefit only weaker pupils, but not those who are already doing well in school. The use of mobile phone apps to support parents with ideas for interacting with their children also shows promise for developing cognitive self-regulation of pre-school children. Cognitive self-regulation measures the child's

ability to work things out for themselves, persistence in completing difficult tasks and making decisions independently. This suggests that digital communication may help reduce attainment gaps among children. There is also suggestion that such intervention would be more feasible to implement if it was targeted at certain groups rather than as a universal intervention.

Digital technology with inconclusive evidence

Home computer with monitoring

Although home computers are available in almost every home nowadays and the advance in internet platforms as learning tools has made home learning easier, there has been very little robust research in its use as a form of parental involvement. It has to be noted that only five studies were found, some were rather outdated, going back to the early 1990s and early 2000s (Everhart, 1991; Fraser, 1991; Tsikalas & Newkirk, 2008), perhaps at a time when home computers were not ubiquitous in the normal household. Nevertheless, the finding may be relevant to children living in poverty where access to home computers and the internet, which many of us take for granted, is not available.

There is inconclusive evidence of the benefit of using of home computers or portable devices such as tablets and iPads on children's learning. There are five studies reporting 20 outcomes. Of the five studies two were rated 2🔒 (Everhart, 1991; Fraser, 1991), the rest were rated 1🔒 and below. Tables 7, 8, 9 summarise the number of the studies on the home computer and the effects on student and parental outcomes. See Appendix 3 for more information of the outcomes and their evidence ratings.

Insert Tables 7, 8 and 9 here

Everhart (1991) evaluated the Take Home Computer Program (THC) where families were loaned computers for six weeks and shown how to interact with their children in a fun and enjoyable way using computers as learning tools. Positive effects were reported for Reading Comprehension (treatment group made gains of 7.83 points but control group gained 4.91 points), but not for Reading measured using the California Achievement Tests (experimental group regressed by 1.36, while control group regressed by 1.12). In general, students, teachers, and parents were reportedly positive about the program according to survey responses. This was a quasi-experimental study focused on students in Grades 3 to 8 who scored below the 49th percentile on the California Achievement Tests in a south eastern state of USA. 70 students were assigned to the treatment group and participated in The Take-Home Computer Program. A comparison group was created artificially of 72 students, of whom three dropped out and seven changed schools. The attrition rate was 9%. The post-test reading scores of these two groups were compared using California Achievement Tests.

Another quasi-experimental study of a take home computer intervention using a matched comparison design involving 846 children from 76 schools (59 control and 17 treatment) reported mixed results on children's maths and reading (**Fraser, 1991**). Tests were measured using the Iowa Tests of Basic Skills (ITBS). Positive effects were found for middle school maths (g= 0.3) and reading (g=0.16), and a small effect for primary school maths (g=0.14), but not for reading (g=-0.12). The intervention lasted six weeks when families were loaned take-home computers. Instructional and enrichment materials were provided, and parents were shown how to interact with their children using computers as learning tools. Interestingly, the study reported a decrease in the time parents spent on doing homework with their children,

with middle school parents showing a bigger drop, from an average of 65 minutes before intervention to 46 minutes after the intervention. Parents also reported positive changes in their children's learning such as increases in interest and time on task.

The other studies were rated 1🔒 and below. These are studies with very small samples (e.g., Adadevoh, 2011), using convenient randomization (Ball & Skrzypek 2019) or had no comparison group (Tsikalas & Newkirk, 2008). Adadevoh compared the use of home computers with and without monitoring. Positive effects were reported for maths (g=0.37) and reading (g=0.10), but no effects on English language arts (g=-0.03). Parental monitoring, however, is effective in raising achievement for language arts (g=0.38) and reading (g=0.28), but not for maths (g=-0.11). There were only 28 primary pupils in the study. Ball & Skrzypek (2019) randomly selected two classes to receive home tablets and broadband access and another class to control. There was no difference in children's cognitive engagement (η^2 = .00), behavioural engagement, η^2 = .03], affective engagement η^2 = .01] and academic motivation η^2 = .04]. Tsikalas & Newkirk (2008) considered the use of refurbished home computer with software and internet access for disadvantaged secondary school pupils. The programme, known as Computers for Youth (CFY), requires students to attend one workshop with one adult family member. These students were invited to take part in the programme. Most of the differences in students' maths performance were explained by their prior attainment. Home computer use did not contribute to students' maths achievement.

Summary

The evidence for the use of home computers with parental monitoring is still unclear. Only five studies that met our inclusion criteria were found and, of these, only two were rated 2🔒.

Everhart (1991) found beneficial effects of using the computer on reading comprehension compared to not having the home computer, but not for reading. Fraser (1991) reported positive effects on maths and reading for middle school children but very small effects on primary school pupils' maths, and negative effects on their reading. In other words, children who did not have a home computer did better in reading than those who had a home computer. However, it has to be noted that these were all quasi-experimental studies where the comparison and treatment children were not the equivalent, and matching can never ensure that the groups are the same on unobservable characteristics. Another study with low weight of evidence found that most of the difference in students' maths performance was explained by their prior attainment (Tsikalas & Newkirk 2008). One other study also found mixed results – positive for some subjects and no effects on others. Another study showed no effects on all student outcomes based on student self-report.

Approaches with no evidence of promise

Online technological devices & digital media for parental engagement

Six studies deemed eligible for inclusion reported the effects of other technology devices used to engage parents in children's learning. These evaluated the use of online homework tools and digital media such as television programmes and videos. Only two were rated 2🔒. Tables 10, 11 and 12 summarise the number of studies and outcomes. For more details see Appendix 4.

Insert Tables 10, 11 and 12 here

A randomised control trial of a Turkish version of Sesame Street, known as Benimle Oynar Misin (BOM) (translated as Will You Play With Me?) showed that children who watched the programme at least three times a week made significant gains in arithmetic readiness, syllabification, and vocabulary compared to children who watched an alternative programme (**Baydar et al., 2008**). Children who watched BOM 1-2 times a week made significant gains in their arithmetic readiness, spatial analogy, and vocabulary. However, children who watched only once a week made progress only in vocabulary. The control group who were not given any programme to watch made some progress but not as pronounced as children in the experimental group. The study targeted pre-school children in Turkey from low socioeconomic background and who had limited access to formal preschool education. Mothers and children were randomly assigned to three conditions: an experimental group (n=139) who watch BOM every weekday for 13 weeks, a control group (n = 127) who watch an entertainment programme at the same time as BOM, and a natural observation group that was informed about the potential benefits of BOM but was asked not to watch it. Because the researcher-developed test measured cognitive outcomes that are specifically targeted by BOM, the control group is thus disadvantaged since they are not exposed to BOM. The strength of evidence for this study is therefore lowered, hence the 2🔒.

Reagan (1982) evaluated a computer-based programme, known as Operation Fail-Safe, which is designed to help parents support their children's reading. The programme offers parental home tutoring and parental conferencing. The study involved 185 Grade 3 pupils (age 8-9) from four primary schools in the US, whose parents volunteered, and another 195 pupils from 20 other schools who were used as a control group and were given no parental support. The results showed no difference between the two groups on reading comprehension measured

using the Iowa Tests of Basic Skills. For the test of vocabulary, ANOVA (Analysis of Variance), which was conducted to take account of the fact that the two groups were not equal at pre-test, showed that treatment pupils made approximately 1.5 months more progress than non-participating pupils. The level of parent participation is associated with children's achievement score (r=44). Survey of parent involvement showed an increase in parental participation by 57% points in the year when Operation Fail-Safe was in place.

The other four studies were rated 1🔒 and below. These are weaker studies using convenient randomisation (Hooker, 2014) or single-group pre-post design (McCollum, 2018; Lewis, 2003) or have unequal comparison group (Boyd, 2018).

Hooker examined the effects of an online homework intervention for primary school children, which involves after-class videos for parents on children's science performance. The study reported an increase in parental participation in children's school activities and children also completed more homework assignments correctly. In a similar study McCollum (2018) examined the effects of a maths online tool, known as EngageNY for primay school children, which also involves the use of online videos for parents. The tool was designed to engage parents to help with their children's homework completion and achievement in maths. The study suggests that although the online videos helped improve children's maths performance, it had a negative impact on parental engagement with children's homework.

Another online tool to support parental involvement and children's homework completion, known as *Calling All Homework.com* posts all homework assignments and notifications of upcoming tests online. Parents were provided a link to email the teacher/researcher for

enquiries. An evaluation of this tool involving children in Grade 6 (age 11-12) reported an increase in the number of correct assignments completed and homework completion (Lewis, 2003). Boyd (2018) evaluated a technology-enabled assessment tool that provides Grade 6 and 7 students with guidance and feedback and diagnostic reports for students, parents and teachers. The study reported that 16 students who completed the workbook intervention had a higher maths achievement than the 53 who did not. There is no evidence of the influence of parental involvement on children's summer slide.

Summary

In summary, there is very little evidence that online technology designed to help parents to support children's homework completion had any beneficial effects on children's academic outcomes. All studies reported positive results on maths achievement and all but one reported improvement in parental engagement. Baydar et al., (2008) suggested positive effects of children's television programme on school readiness. This was the strongest study in this group, but because of the high level of missing cases from one arm of the intervention and the use of a researcher-developed test, the weight of evidence is still weak. The other four studies had very small samples, three of which had no comparison groups or unequal comparison group (Boyd, 2018; Hooker, 2014; Lewis, 2003) and one measured outcomes using teacher report or student perceptions of improvement (Mccollum 2018). All this makes the evidence rather weak

Discussion

There is scant evidence so far that digital devices or software applications have been effective in supporting parental engagement that can lead to improvement in children's school outcomes.

One of the reasons for the lack of promising evidence is the dearth of robust studies to test the causal link. Only one study included suggested a reduction in teachers' time calling parents, but this did not translate to improvements in students' attainment or attendance. The evidence for this is weak.

The review, however, found reasonably good evidence that the low-cost technology nudges such as school-parent communication via phone, texts or emails is promising. Similar findings were reported in a systematic review by the Abdul Latif Jamel Action Lab (J-PAL Evidence Review 2019). Given the relatively low-cost of such interventions, this could be a cost-effective way to engage with parents with positive results on children's education. There is already existing evidence that communicating with parents about how their children are doing in school and keeping them informed of schoolwork can have positive effect on children's learning (van Poortvliet et al., 2018). But such messages must be personalised, linked to learning and positive. Communication should be two-way allowing parents to be consulted. Tips, support and resources can help make home activities with children fun and effective. Some useful resources suggested by van Poortvliet et al. to support parents' engagement with their children's learning and how schools can support parents and carers at home are available on the EEF website. To that extent the findings are some reassurance for those concerned about loss of learning during prolonged periods of school closure, as in the recent coronavirus lockdown, for poor children who have no access to iPads or tablets or the internet. Frequent and consistent communications with parents via emails and texts may be a way to overcome such barriers.

Implications for future research

In our search for programmes that facilitate schools' engagement with parents, we have come across a large number of them on the internet, many indicating effective support for parental engagement, that are already widely used in schools. However, only a few of these have been evaluated (as discussed in this review). Some have been used in over 500 schools. Developers of such programmes often use the reach and spread of use in schools as an indication of impact. And much of their evaluation is based on anecdotal reports from parents and teachers. To be certain of the effectiveness of such programmes (just as we want to be certain of the efficacy of any Covid-19 vaccine we receive), these programmes need to be tested robustly. This means that the research design has to be able to suggest causation – that is, using the parental engagement software leads to improved outcomes. Such designs would usually involve randomising groups so that we can compare the outcomes of those who receive the programme and those that do not. The scale has to be large to avoid inherent systematic differences between groups. The trial has to be as intact as possible because any drop out would render the groups unequal. And the instruments or tests used to measure the outcomes have to be independently developed (i.e., not by the developer). Ideally the programme is evaluated by independent researchers with no conflict of interest. Not doing any of these could reduce the credibility of the findings.

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APPENDIX 1

Syntax used in the electronic database searches

((parent* OR mother* OR father* OR carer* OR caregiver* OR guardian*) AND (engage* OR involve* OR "parenting style*" OR "parental participation") AND ("digital technology" or "EdTech tool*" or EdTech or computer or software or app* or technology or "educational technology" or "mobile device*") AND (evaluat* or interven* or trial or experiment or review or "meta analys*" or cause* or effect* or determinant or "regression discontinuity" or instrumental variables or longitudinal or "randomi* control" or "controlled trial" or "cohort study" or "systematic review") AND (attain* or achiev* or outcome* or "learning outcome*" or "school outcome*" or "cognitive outcome*" or academic or "other outcome*" or "critical thinking" or "key stage*" or exam* or qualification* or "school readiness" or "test score*" or "non cognitive" or attitude or expectation or aspiration or behave* or intention or motivation or self-efficacy or "locus of control" or attendance or absen*or workload or "teach* workload" or "teach* time" or "teach* hour*") AND (child* or school or teacher or educat*))

APPENDIX 2

Summary of studies on digital communication on student and parental outcomes (18 studies, 51 outcomes)

	Study reference	Outcomes	Effects	Rating	Age group
1	Bergman (2015)	High school GPA (Grade Point Average) and maths	+0.21	3🔒	8-17
		English	+0.04	3🔒	8-17
		Coursework completion	Improvement of 7.5%	1🔒	8-17
		Absenteeism	Reduction by 38%	1🔒	8-17
		Parent-teacher meeting	Increase by 53%	1🔒	8-17
		Parent contact by teachers	Increase by 187% for high school students and 106% for middle school students	1🔒	8-17
2	Miller et al. (2017)	Maths	+0.07	3🔒	11-16
		English	+0.03	3🔒	11-16
		Science	-0.01	3🔒	11-16
		Absenteeism	-0.11 (only for KS4 pupils)	2🔒	11-16
		Maths for EAL (English as an Additional Language)	-0.04	3🔒	11-16
3	Robinson-Smith et al. (2019)	Language development	+0.04	3🔒	3-4
		Cognitive self-regulation	+0.14	3🔒	3-4
4	York & Loeb (2014)	Literacy	+0.11	3🔒	4
		Parental engagement in home literacy	+0.16	1🔒	4
		Parental involvement in school	+0.14	1🔒	4
5	Jelley & Sylva (2018)	Cognitive self-regulation	+0.35	2🔒	
		Parental control	+0.26	2🔒	
6	Jelley, Sylva & Karemaker (2016)	Cognitive self-regulation	+0.44	1🔒	2-6
		Parental consistency & discipline	+0.51	1🔒	2-6
7	Jordan (1994)	Grade 5 homework completion for maths,	Mixed effect Negative for Grade 5 maths,	1🔒	10-11

		language arts and social studies	language arts and social studies No effect for Grade 6 maths, language arts and social studies, but Significant increase from baseline for language arts		11-12
		Report card grades for language arts	Increased from 9 to 10.2 on a 13-point scale	1🔒	11-12
8	Bouffard (2007)	Grade 12 achievement scores	+0.08	1🔒	16-18
		Parent-child discussion	+0.08	1🔒	16-18
		Homework involvement	+0.1	1🔒	16-18
		Educational expectations	+0.15	1🔒	16-18
9	Fitzpatrick (2013)	Tennessee Comprehensive Assessment of maths	+0.01	1🔒	11-12
		Discovery Education Assessment Test	+0.1	1🔒	11-12
		Maths GPA	0	1🔒	11-12
		Maths confidence	0	1🔒	11-12
10	Hurwitz et al. (2015)	Parental engagement in children's learning	Reported significant effects on parental engagement	1🔒	0-5
11	Radin (2013)	Parental engagement	0	1🔒	13-14
		School involvement	0	1🔒	13-14
		Cognitive involvement	0	1🔒	13-14
		Student behaviour	Negative	1🔒	13-14
12	Bauch (1994)	Parent-teacher communication	Positive result Increased phone calls by 400%	0	Primary, middle/junior high and senior high
		Homework completion rates	No effect	0	Primary, middle/junior high and senior high

		California Achievement Test on reading, maths and language	Positive results Significant differences between control and treatment in 16 of the 34 categories at post-test compared to 7 of 34 categories at pre-test	0	Primary, middle/junior high and senior high
13	Castaneda (2019)	Maths, English reading and writing	Mixed results Improvement in maths and no improvement in English in one school. No improvement in maths and English reading but a slight improvement in English writing in a second school	0	12-14
14	Dardenne (2010)	Maths	Positive results Levels of internet and email use explained 27% of the between-school variance in math scores	0	Middle school
		Literacy	Positive results Explains 15% in literacy scores	0	Middle school
15	Beck (2013)	Homework completion	Positive results Reported improvements in homework completion	0	4-6
		Parent-teacher contact	No improvement in parent-teacher contact	0	4-6
16	Davidovitch & Yavich (2015)	Parental engagement	Positive correlation between parental engagement and children's perceived	0	9-12

			academic achievement		
17	Ellis (2008)	Parent-school communication	Reported positive benefits	0	9-12
		Parent-student interaction	Reported positive benefits	0	9-12
		Academic outcomes	Reported positive benefits	0	9-12
		Homework completion	Reported positive benefits	0	9-12
18	Pakter & Chen (2013)	Teacher reported grades in physics	Negative (-1.6% point difference between treatment and comparison group)	0	High school
		School attendance	Negative (-0.7% point difference)	0	High school
		Parent-teacher contact	Positive result Increase in parent-teacher contact	0	High school
		Teacher workload	Positive Reduction in time teachers spent callings parents	0	High school

APPENDIX 3

Summary of studies on the use of home computer on student and parental outcomes (5 studies, 21 outcomes)

	Study reference	Outcomes	Effects	Rating	Age group
1	Everhart (1991)	Reading comprehension	Mixed effects Gains of 2.92 points compared to control for reading comprehension But negative effect on the California Achievement Test for Reading (-0.24)	2🔒	8-14
2	Fraser (1991)	Maths (Iowa Test of Basic Skills) (ITBS)	+0.3	2🔒	11-13
		Reading (ITBS)	+0.12	2🔒	11-13
		Maths (ITBS)	+0.14	2🔒	5-10
		Reading (ITBS)	-0.12	2🔒	5-10
		Parental engagement	Negative	0	5-13
		Student attitude	Positive	0	5-13
3	Adadevoh (2011) (home computer usage)	Maths	+0.37	1🔒	9-10
		Reading	+0.10	1🔒	9-10
		English language arts	-0.03	1🔒	9-10
4	Adadevoh (2011) (home computer usage with monitoring)	Maths	-0.11	1🔒	9-10
		Reading	+0.28	1🔒	9-10
		English language arts	+0.38	1🔒	9-10
5	Ball & Skrzypek (2019)	Affective engagement	0.01	1🔒	9-11
		Academic motivation	0.04	1🔒	9-11
		Cognitive engagement	0.00	1🔒	9-11
		Behavioural engagement	0.03	1🔒	9-11
		School support	+1.36	1🔒	9-11

6	Tsikalas & Newkirk (2008)	Maths	No effect Most of the differences explained by prior attainment	0	11-13
		Student confidence and school engagement	Students reported positive effect	0	11-13

APPENDIX 4

Summary of studies on online technological devices for parental engagement (6 studies, 17 outcomes)

	Study reference	Outcomes	Effects	Rating	Age group
1	Baydar et al. (2008)	Arithmetic readiness (high & medium exposure) No effect with low exposure	**+0.11**	2🔒	5-7
		Categorisation (high, medium & low exposure)	No effect +0.02, +0.05; +0.03	2🔒	
		Spatial analogy skills (high, medium & low exposure)	Small effect +0.07; +0.09; +0.02	2🔒	
		Syllabification (high, medium & low exposure)	Small effect but no effect with low exposure +0.12; +0.05; -0.08	2🔒	
		Vocabulary (high, medium & low exposure)	Small effect +0.11; +0.19; +0.08	2🔒	
2	Reagan (1982)	Reading comprehension	0	2🔒	8-9
		Vocabulary subtest	1.5 months more progress	2🔒	8-9
3	Hooker (2014)	Parental participation in school activities	15% increase	1🔒	8-9
		Number of accurate assignments completed	Positive effect	0	9-10
4	McCollum (2018)	Maths	+0.23	0	10-12
		Homework completion	0	0	10-12
		Parental engagement in children's learning	Negative	0	10-12
5	Lewis (2003)	Number of homework completed	Positive	0	11-12

		Number of accurate assignments completed	Positive	0	11-12
6	Boyd (2018)	Maths	+0.11	0	11-13
		Parental involvement on summer slide	-0.83	0	11-13

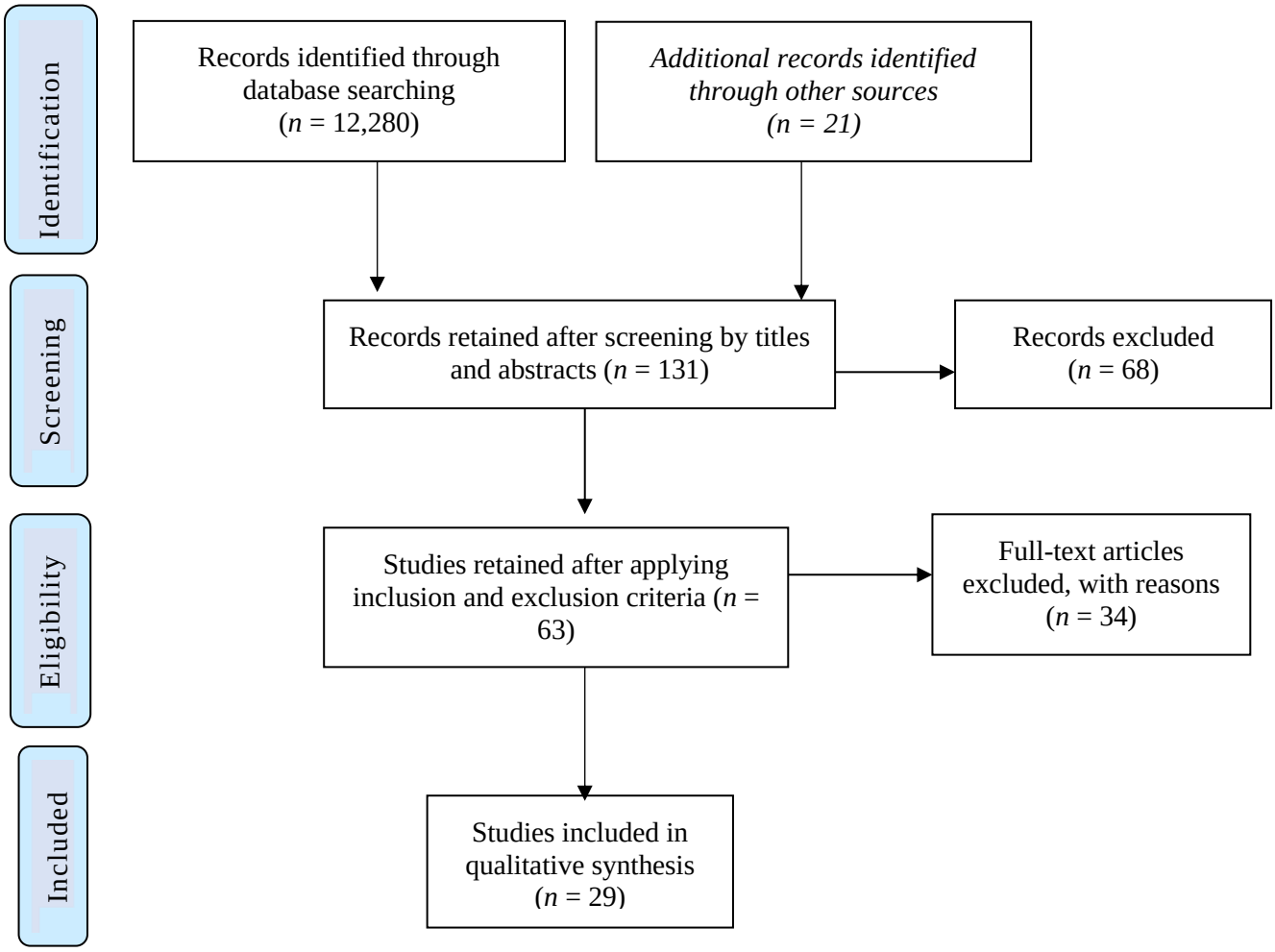

Figure 1: Flow chart from identification of studies to quality-assessment

Flow chart adopted from Moher et al. (2010)

Table 1: Databases/search engines

Applied Social Sciences Index and Abstracts: ASSIA	PsycINFO
British Education Index	Sage Journals
Ebscohost	ScienceDirect
ERIC	Scopus
Google Scholar, Google	Springer Link
JSTOR	Web of Science
ProQuest Dissertations and Theses Global	Wiley Online Library
PsycARTICLES	

Table 2: Database search outcomes

Database/search engines	**Number of studies picked up**	**Number exported to EndNote**
Web of Science Core Collection	2,873	23
ProQuest	3,892	31
ProQuest dissertation and Theses	1,639	11
PsychINFO	2,565	20
British Education Index	101	2
Web of Science	1,011	1 (many were duplicates from earlier databases)
Wiley Online Library	182	5
Google Scholar, Google	17	17
Total	**12,280**	**110**

Table 3: Quality appraisal "sieve" for causal studies

Design	**Scale**	**Dropout**	**Outcomes**	**Other threats**	**Rating**
Fair design for comparison (e.g., RCT)	Large number of cases per comparison group	Minimal attrition with no evidence that it affects the outcomes	Standardised pre-specified independent outcome	No evidence of diffusion or other threat	4🔒
Balanced comparison (e.g., Regression Discontinuity, Difference-in Difference)	Medium number of cases per comparison group	Some initial imbalance or attrition	Pre-specified outcome, not standardised or not independent	Indication of diffusion or other threat, unintended variation in delivery	3🔒
Matched comparison (e.g., propensity score matching)	Small number of cases per comparison group	Initial imbalance or moderate attrition	Not pre-specified, but valid outcome	Evidence of experimenter effect, diffusion or variation in delivery	2🔒

Comparison with poor or no equivalence (e.g., comparing volunteers with non-volunteers)	Very small number of cases pr comparison group	Substantial imbalance or high attrition	Outcomes with issues of validity and appropriateness	Strong indication of diffusion or poorly specified approach	1🔒
No report of comparator	A trivial scale of study (or N unclear)	Attrition not reported or too high for comparison	Too many outcomes, weak measures or poor reliability	No consideration of threats to validity	0

Table 4: Summary of digital communication on academic outcomes (19 outcomes)

Strength of evidence	Positive outcome (*n* = 13)	Unclear/mixed outcome (*n* = 1)	Neutral or negative (*n* = 5)
3🔒	6	-	2
2🔒	-	-	-
1🔒	3	-	2
0	4	1	1

Table 5: Summary of digital communication on non-academic outcomes (13 outcomes)

Strength of evidence	Positive outcome (*n* = 8)	Unclear/mixed outcome (*n* = 1)	Neutral or negative (*n* = 4)
3🔒	1	-	-
2🔒	2	-	-
1🔒	3	1	2
0	2	-	2

Table 6: Summary of digital communication on parental involvement outcomes (20 outcomes)

Strength of evidence	Positive outcome (*n* = 16)	Unclear/mixed outcome (*n* = 0)	Neutral or negative (*n* = 4)
3🔒	0	-	-
2🔒	1	-	-
1🔒	10		3
0	5	-	1

Table 7: Summary of evidence of home computers on academic outcomes (12 outcomes)

Strength of evidence	Positive outcome (*n* = 7)	Unclear/mixed outcome (*n* = 1)	Neutral or negative (*n* = 4)

3🔒	-	-	-
2*	3	1	1
1*	4	-	2
0	-	-	1

Table 8: Summary of evidence of home computers on non-academic outcomes (6 outcomes)

Strength of evidence	Positive outcome (*n* = 2)	Unclear/mixed outcome (*n* = 0)	Neutral or negative (*n* = 4)
3🔒	-	-	-
2🔒	-	-	-
1🔒	-	-	4
0	2	-	-

Table 9: Summary of evidence of home computers on parental outcomes (2 outcomes)

Strength of evidence	Positive outcome (*n* = 1)	Unclear/mixed outcome (*n* = 0)	Neutral or negative (*n* = 1)
3🔒	-	-	-
2🔒	-	-	-
1🔒	1	-	-
0	--	-	1

Table 10: Summary of evidence of online devices on academic outcomes (9 outcomes)

Strength of evidence	Positive outcome (*n* = 7)	Unclear/mixed outcome (*n* = 0)	Neutral or negative (*n* = 2)
3🔒	-	-	-
2🔒	5	-	2
1🔒	-	-	-
0	2	-	-

Table 11: Summary of evidence of online devices on non-academic outcomes (4 outcomes)

Strength of evidence	Positive outcome (*n* = 3)	Unclear/mixed outcome (*n* = 0)	Neutral or negative (*n* = 1)
3🔒	-	-	-
2🔒	-	-	-
1🔒	-	-	-
0	3	-	1

Table 12: Summary of evidence of online devices on parental outcomes (4 outcomes)

Strength of evidence	Positive outcome (*n* = 2)	Unclear/mixed outcome (n = 0)	Neutral or negative (*n* = 2)
3🔒	-	-	-
2🔒	-	-	-
1🔒	2	-	-
0	-	-	2