Supporting science teachers to engage with and carry out research

Research Report:

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Executive Summary

The Wellcome programme and the research

Wellcome provided grants for the development and piloting of four CPD projects, each of which took a different approach to supporting science teachers to engage with or carry out pedagogical research. This mixed-methods study measured the outcomes of teachers engaging with or carrying out research and explored how science teachers approached, and were most effectively supported to, engage with or carry out research.

Recruitment, engagement and retention

In total, 468 science teachers were recruited across the programme, three-quarters of the intended target. Participants' main motivations for joining the programme were the opportunities it offered to improve practice, pupil engagement and scientific understanding, as well as to engage with, use and/or carry out research. The formal withdrawal rate from the programme was high (19%), and likely an under-estimate due to monitoring issues faced by some projects.

Recruitment, engagement and retention were negatively impacted by the COVID-19 pandemic and the associated pressure it placed on schools and teachers. Time and workload, exacerbated by the COVID-19 pandemic, were the main barriers to recruitment and engagement. Recruitment was easiest where school leaders were approached to sign up whole teams or departments and facilitated when school leaders made arrangements to free up the teachers' time so that they could participate.

Outcomes

Overall, the programme appears to have had positive outcomes. Baseline and endpoint surveys identified statistically significant improvements following participation in the programme[1] on outcome measures related to:

- confidence in accessing, assessing the quality of, and applying research – these factors had moderate to large effect sizes, with their Cohen's d ranging from 0.500 – 0.542
- using research in practice – this factor had a moderate effect size of 0.328
- enhanced science pedagogical practices across a range of pedagogic measures – the effect sizes for these factors were all small to moderate, ranging from 0.172 – 0.299.

[1] Note that the Wellcome grant did not make provision to survey a comparison group of teachers, so we were unable to measure the counterfactual. We cannot, therefore, claim a causal link between the programme and these observed outcomes.

For participants in the only project that provided support for teachers to carry out their own research, an additional increase in confidence related to carrying out research was found. These findings were not significance tested due to small sample size.

The qualitative findings generally supported the quantitative findings. Most project interviewees reported that they had used research to inform thinking and discussion. Some participants reported that they had used research to align some of their practices more closely with research evidence. The majority of those interviewees who had not made changes to their practices intended to do in the following academic year. There were a few instances where research was used to validate personal practices or by team and department leaders to drive pedagogical changes across their team or department[2]. In some schools, pedagogical and curricula changes were reported to have occurred across teams or departments as a result of participants sharing research and research-informed resources with colleagues and collaboratively planning for their implementation. Unsurprisingly, these practices were most prevalent in the project that recruited whole teams and departments.

It is possible that the quantitative and qualitative findings present a somewhat optimistic picture. This is because they rely on self-reported data, projects generally recruited teachers with a positive orientation towards research use and drop-out rates from the projects were high. In addition, there was survey attrition, so the final sample size was relatively small. Nonetheless, the findings are encouraging, especially as remote learning and the limitations to the delivery of science teaching due to COVID-19 restrictions in schools reduced opportunities for participants to implement learning from their project.

Brokering, using and doing research

Brokerage spans the activities, resources, and motivations within which pedagogical research is exchanged, transformed to inform practice, and otherwise communicated.[3] Within the Wellcome programme both the project teams and teacher participants acted as brokers.

The focus of the brokerage provided by the project teams varied according to the individual project's aims. Across the programme, the brokerage activities and resources included support for participants to:

- access and engage with pedagogical research sources – including assessing their quality and understanding the findings
- translate research into ideas, plans and resources to use in school and/or adapt research-

[2] Informing thinking and discussion aligns with the concept of 'conceptual research use'; changing practices to align with research evidence, aligns with 'instrumental research use'; and using research to legitimise an approach, persuade others of its value or validate exiting practice aligns with 'strategic use' (Weiss, 1979; Nutley, 2013).

[3] Adapted from Farley-Ripple et al. 2017.

informed lesson plans and teaching and learning resources produced by the project teams
- implement research ideas and/or research-informed resources in school
- design and carry out pedagogical research.

Few participants accessed research sources beyond those provided by their project. Their depth of engagement with research appeared to be determined by the nature of the research provided by their project. Engaging with and translating research for use in practice were highly inter-related processes. Structured discussion and questioning by the project facilitators, the use of critical appraisal and critical implementation tools, and the sharing of professional experience with research-interested colleagues appeared to support participants' engagement with, and translation of, research.

Some project teams brought together researchers and experienced teachers to translate research into research-informed resources for use by project participants. Although this process was challenging at times, it was most effective when:

- equal weight was given to both researcher and teacher knowledge
- there were regular opportunities for communication and collaboration between the researchers and teachers - to share knowledge about the research and the school context
- topic, subject-specific, science and generic pedagogical research were brought together.

Where projects provided research-informed resources, participants selected those where there was a fit between the topic and the scheduling of their curriculum. Participants were expected to, and did, adapt the resources, making changes to lesson sequencing, structure, assessment, science vocabulary and the design and content of the associated teaching and learning resources. The reasons for adaptation included teacher judgment and preferences, and a match with the pupils' needs and school requirements. Implementation was faster when the resources were easy to use. The question of whether the adaptations might compromise fidelity to the research, and so lead to less effective practices, did not appear to have been considered.

Many of the participants brokered research and research-informed resources in their teams and departments. For these participants, discussion with their colleagues was a key element of translating research, adapting research-informed resources to inform practice, and planning implementation. This brokerage of research by participants and participants' own use and/or conduct of research, was reported to be easier when there was a culture of collaboration in their schools and teacher were able to experiment with their practices. In schools where collaborative lesson and curriculum planning were well-established, there appeared to be more widespread implementation of learning from the projects.

Those participants who had implemented research ideas or research-informed practices in their school did this through a ‘plan, do, review’ cycle. They reported that this was aided through discussions with project and school colleagues, as well as gap tasks, implementation tools, and mentoring. The participants who undertook research reported that this was aided by the initial training, resources and a template that scaffolded the design process, as well as ongoing one-to-one support.

Effective brokerage by CPD providers

The findings indicate that CPD projects are most likely to be effective in brokering and supporting the implementation of research if they provide:

- an integrated package of support, including training, high-quality resources and one-to-one support, which is made available in a timely way and compatible with the school curricula and the pattern of the academic year
- regular training sessions or other meetings that are easily accessible and flexible, for example sessions that are offered more than once and/or recorded to enable catch-up, or the provision of self-paced online training
- opportunities for discussion with peers during project sessions
- tools to support engagement, translation, and implementation that are structured to scaffold these processes
- regular opportunities for support, for example during workshops, group meetings and drop-ins, as well as swift, comprehensive answers to queries and concerns on a one-to-one basis
- research-informed resources (if provided) that are: presented as an easy to adapt package of lesson plans with associated teaching and learning resources; focused on difficult-to-teach topics; informed by topic-specific, broader science and generic pedagogical research; linked to the National Curriculum and the underpinning evidence.

Other important factors included: for mixed-phase CPD, ensuring that the project activities and resources are relevant to both primary and secondary science teachers; and, for the CPD projects supporting trainee teachers, ensuring that the learning is appropriately scaffolded.

Conclusions

Supporting teachers to engage with and carry out research has the potential to improve the quality of science teaching. This can be achieved by the provision of a range of CPD programmes that provide an opportunity for teachers to engage with or carry out research that meets their interests, the requirements of their school and the amount of time that they are prepared to dedicate to this aspect of their professional development. Such CPD programmes are most effective when school leaders ensure that a collaborative culture is in place and teachers are encouraged to experiment with their practices.

Research design

This concurrent mixed-methods study comprised:

- baseline and endpoint participant surveys to measure change-over-time in relation to the intended outcomes and participants' perceptions of the projects at endpoint
- one-to-one or group endpoint interviews with 80 participants; sets of one-to-one, longitudinal interviews with a further 17 participants, longitudinal interviews with all project teams, and 12 observations, to explore research brokerage and participants' approaches to engaging with and carrying out research
- an analysis of the Management Information (MI) data, collected by the projects, to identify recruitment and participation patterns.

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Chapter 1: Introduction

Chapter 1 sets the context of the study by providing an:

- introduction to Wellcome's '*Supporting teachers of science to engage with and carry out research*' programme and Theory of Change (ToC)
- overview of the policy, practice, and research context, and study rationale
- outline of the study methodology - research aims, conceptual tools and methods.

1.1 Introduction to the programme

Wellcome launched the 'Supporting teachers of science to engage with and carry out research' programme in summer 2019. Grants were awarded to four pilot projects that aimed to support teachers to engage with pedagogical research or carry out small-scale research projects, with the aim of improving science teaching. The selected projects were judged to have the potential to be scalable and lead to relatively easy-to-implement changes to teachers' practices.

Three of the projects aimed to support teachers to engage with pedagogical research:

- **Journal Clubs**, provided by the Chartered College of Teaching, focused on supporting teachers to engage with and translate research from academic and professional journals to inform practice, and plan for implementation in schools
- **Evidence in Action**, provided by the Behavioural Insights Team, developed research-informed lesson plans and associated resources, with hyperlinks to the underpinning research summaries, and supported teachers to engage with the these and plan for their use in schools
- **Research-2-Practice**, led by Roehampton University in collaboration with the University of Lincoln, York St John University and KYRA Research School, developed research summaries and associated lesson plans for use by trainee teachers supported by their initial teacher education (ITE) mentors, and provided initial training to these mentors.

The fourth project supported teachers to carry out pedagogical research:

- **Teacher-led RCTs (Randomised-controlled trials)**, provided by a partnership between the Education Development Trust and STEM Learning, supported teachers to design and carry out a small-scale, classroom-based RCT of a research-informed intervention.

All of the projects worked with teachers in the English state-school system. Further information on the projects can be found in Section 2.1. A grant was also awarded to the Sheffield Institute of Education (SIoE), at Sheffield Hallam University and the National Foundation for Educational

Research (NFER) to carry out associated research and evaluation. This report sets out the findings of this research and evaluation.

1.2 Policy, practice and research context and the study rationale

The study aimed to extend the knowledge base on:

- how science teachers engage with and carry out research, and how they can be most effectively supported to do so
- the impacts of engaging with and carrying out research on teachers, pupils, schools, and the wider education system.

These two foci are highly significant in the context of recent developments and issues in science education, teachers' continuous professional development (CPD), research-informed practice and research brokerage.

Science education in English schools

The Wellcome programme set out to improve the quality of science teaching, by supporting teachers to engage with or carry out research, with the longer-term aim of improving the quality of science education and outcomes for pupils. High-quality science education is crucial to enable children and young people to develop the scientific literacy they will need as citizens in an increasingly technologically and scientifically advanced world, as well as being the basis for training future scientists and technicians.

Science is a core National Curriculum subject, alongside English and mathematics, in English primary and secondary schools. While the performance in science of pupils in England is high compared to that in other countries, and there has been a sustained increase in the number of pupils studying science beyond the age of 16 (Ofsted, 2021, STEM Learning, 2021), there are concerns about the quality of science education. Emerging evidence indicates that performance is not improving for all pupils, with disadvantaged pupils making poorer progress in science at every stage of their education compared with their peers (Nunes et al., 2017; STEM Learning, 2021).

Research indicates that high-quality teaching (across all subjects) is the most important school-related factor in improving pupils' performance, but teacher quality varies (Barber and Mourshed, 2007; Jackson, Rockoff and Staiger, 2014). Science teachers' engagement in high-quality CPD is, therefore, crucial in ensuring that all pupils receive the teaching they need in order to succeed.

Teachers’ CPD

The world’s best education systems make a substantial investment in teachers’ CPD (Institute of Physics (IOP), 2020). Reviews indicate the positive effect of CPD on pupils’ learning and attainment in the short-term, as well as higher growth, higher-paid employment, and other positive benefits to countries (Lawton et al., 2021; Fletcher-Wood and Zuccollo 2020). However, many teachers in England are not currently accessing high-quality CPD, and fewer teachers in England access curriculum-specific CPD compared with higher-performing jurisdictions (Cordingley et al., 2018). In the 12 months prior to the 2018 Organisation for Economic Cooperation and Development (OECD)’s Teaching and Learning International Survey, only 58% of the teachers in England who participated in the survey, had carried out CPD related to pedagogical competencies in teaching their subject, compared to 98% of the Shanghai teachers who completed the survey.[4]

A number of reviews have sought to measure the impact of CPD and identify the characteristics of effective CPD, either in general or in relation to a particular form, such as coaching (e.g., Timperley et al.; 2007; Cordingley et al., 2015; Dunst et al., 2015; and Kraft et al., 2018; Sims et al., 2021). This study differs due to its aim to identify the specific features of CPD that most effectively support science teachers to engage with and carry out pedagogical research and assess the related outcomes. The study builds on evaluations of earlier CPD programmes that were designed to increase teachers’ research use (e.g., Maxwell and Greany, 2015; Maxwell et al., 2019c, Lord et al., 2019; Nelson et al., 2019; Rose et al., 2017; Walker et al., 2019).

Research-informed practice in English schools

Supporting teachers to draw on research to inform their practices, as a means to improve the quality of teaching, and ultimately outcomes for pupils, has been a policy intention for well over a decade. Nelson and O’Beirne (2014), Nelson and Campbell (2019) and Coldwell (2022) argue that England now has a well-developed infrastructure for supporting teachers’ research use. This is underpinned particularly by the work of the Education Endowment Foundation (EEF)[5] and the evidence syntheses available from EEF and other organisations. The infrastructure for supporting research-informed science education has been further enhanced through the work of the learned societies, charitable trusts such as Wellcome, and organisations such as STEM Learning. These organisations have invested significantly in researching, and advocating for, teachers’

[4] OECD Teaching and Learning International Survey 2018 Statistical Table 1.5.18 Content of professional development, by teaching experience, available at https://doi.org/10.1787/888933933102.

[5] EEF is England’s ‘What Works Centre’ for education. It commissions RCTs to develop the evidence base and produces a Teaching and Learning Toolkit that summarises evidence and themed Guidance Reports, such as *Improving Secondary Science* (Holman and Yeomans, 2018). EEF Regional leads and the Research Schools Network supports schools to use evidence to improve practice.

research use (The Royal Society, 2018) and/or CPD programmes, designed to increase the use of pedagogical research in schools.

It is perhaps surprising, therefore, that teachers' use of research in English schools has remained relatively low. A 'State of the Nation' study of research-informed practice (Coldwell et al., 2017), as well as national survey-based studies over a five-year period (Nelson et al., 2017; Walker et al., 2019), found that teachers prioritised their own and other teachers' expertise over research evidence, in informing their practice. This is particularly interesting as the surveys also found that teachers regarded research evidence positively.

As Coldwell (2022) points out, this may be due, in part, to school conditions that are not conducive to teachers' research use. Senior leaders' commitment to research use and a school culture characterised by high levels of perceived trust, which focuses on learning and encourages experimentation with practice, have been shown to have a positive impact on teachers' research use. However, these characteristics are not found universally across schools. The absence of these characteristics, as well as instability within the schools' workforce, particularly in the leadership teams, plus a lack of time dedicated to engaging with and carrying out research, have been found to have a negative impact both in England (e.g., Brown and Flood, 2019; Brown et al., 2016; Maxwell et al., 2019a and 2019b; Maxwell et al., 2018) as well as internationally (e.g., see Rickinson et al.'s 2021 Australian study). More broadly, teacher learning is significantly influenced by the school culture, leadership, types of collaboration, and shared (or not) goals and values (Weston et al., 2021).

How teachers engage with, carry out and implement research in their practices, and the related impact of this, is an under-explored field (Cain et al., 2019; Gorard et al., 2020). A better understanding of this is needed to inform decisions about the most effective ways to support teachers to use research. It is currently unclear whether the approach to promoting research-informed practice in England is any more or less effective that those adopted elsewhere. Alternative approaches include: research-practice partnerships (Farrell et al., 2021) and networked improvement communities (Byrk, 2020) in the United States; and the broader focus in Finland on teaching as a highly valued, research-oriented profession, where teachers have considerable autonomy to experiment with their practices (Pollari et al., 2018).

This study aimed to contribute to these gaps in the knowledge base, by exploring, in depth, how teachers engage with, use, and carry out research, and the related impacts of this, in the four Wellcome projects.

Research brokerage

The growing body of evidence on knowledge mobilisation, drawn mostly from medicine- and health-related fields, indicates that the relationship between research and practice is complex and non-linear (e.g., see Boaz et al., 2019). Knowledge flow across the boundaries between different professional groups (for example, researchers and practitioners) can be impeded due to social and cognitive differences (Ferlie et al., 2005; Powell et al., 2017). Differing definitions of knowledge, the practice and policy context, and the multiple stakeholders involved all impact on the flow of research evidence (Powell et al., 2017).

There is limited evidence on the relative effectiveness of different approaches to knowledge mobilisation (Langer et al., 2016). Research brokerage is one approach to mobilising knowledge that has been receiving increased attention in the field of education. Farley-Ripple et al. (2017, no pagination) define research brokerage as '*a dynamic and complex set of actors, activities and motivations, within which research is exchanged, transformed, and otherwise communicated*'. There is a limited but growing body of evidence about the positive impact of research brokerage on research use in schools (see for example: Gu, 2020; Maxwell et al, 2019a and 2019b; Nelson et al., 2019; Rose et al., 2017).

Research brokerage may be led by different actors, at different levels within the education system; for example, EEF acts as a national broker at the macro-level; EEF Research Schools[6] broker research with other schools at a meso level and within schools; while, at the micro level, leaders and teachers broker research with colleagues. Within the Wellcome projects both the project teams and teacher participants acted as brokers. The focus of the brokerage by the project teams varied according to the individual project's aims. Across the programme as a whole, brokerage activities spanned: accessing, and engaging with, research; translation of research to inform practice (including translation by the project teams and supporting teachers to translate research); implementing research and/or research-informed resources in schools, and designing and carrying out research. The teacher participants brokered research sources, research-informed resources and/or carrying out research in their school. The nature of the brokerage undertaken by the projects and participants is explored in Chapter 3.

Exploration of the project's approaches to research brokerage, how teachers respond to this brokerage, and the impact brokerage has on research use, science practice and wider outcomes, in this study, was intended both to contribute to the knowledge base on research use and also provide insights to guide the design and delivery of CPD programmes that aim to support research use.

The COVID-19 pandemic

The arrival of COVID-19 in the UK in early 2020, subsequent lockdowns and partial school closures had a significant impact on schools and teachers (Achtaridou et al., 2022, Greany et al., 2021; Nelson and Sharp, 2020; Sharp et al., 2020). This in turn impacted on the projects and this

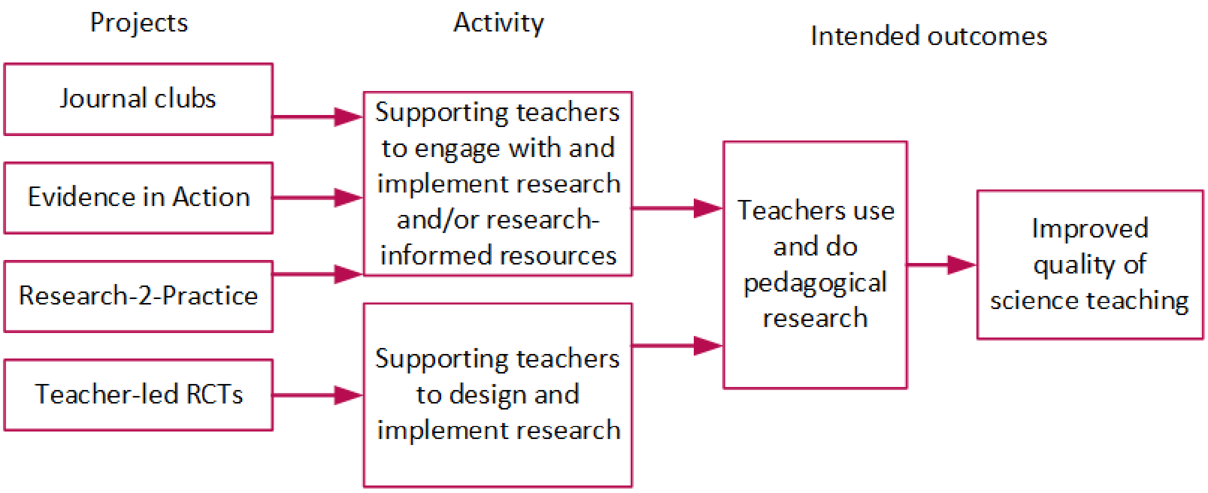
[6] EEF Research Schools are designated to work with other schools to support them in using evidence to improve teaching practices.

study. The project teams responded sensitively to the continually changing school context. One of the main areas of difficulty was the recruitment of participants, which was followed by high levels of drop-out. Project timelines were extended and activities adapted; for example, CPD activities were moved online. The impacts on the projects and participants are discussed in greater depth in Chapters 2-6. The study timeline and methods (Section 1.4) were adapted in response to project changes, the challenges of collecting data in this context, and the desire to minimise the burden on teachers during this challenging time.

1.3 Theory of Change

During an initial workshop the study team supported the Wellcome programme leaders to develop a programme ToC. ToCs outline the intended long-term outcomes of a programme, any intermediate outcomes necessary to achieve these, and the activities that will support progress. They express the logic underpinning any causal assumptions and take into account any contextual factors that may support or confound progress. A simplified representation of the Wellcome programme's ToC is presented in Figure 1. The full version can be found in Appendix 1.

Figure 1: Simplified Theory of Change



The programme was intended to contribute to Wellcome's vision of improving young people's outcomes in science, more effective science education, and the generation and use of high-quality pedagogical research. By providing grants for the development and delivery of the projects, the programme aimed to improve science education by supporting teachers to:

- be confident, research literate and skilled users of research
- be knowledgeable about the content of pedagogical research
- seek out research to inform their classroom pedagogy and encourage their colleagues to do the same
- adapt their practices in order to align them more closely with research; and

- embed and sustain these changes in their practices.

Intended intermediate and longer-term outcomes for the participants are shown in Box 1. The ToC was based on the assumption that CPD which improves the participants' awareness and knowledge of the relevant research, research literacy, and ability to carry out research, as well as encouraging collaboration and fostering research use empowerment will lead to the desired outcomes.

Box 1: Intended participant outcomes

Intermediate outcomes for the participants (achieved by the end of the project)

- raised awareness of the richness and relevance of research
- improved research literacy
- engagement in collaborative dialogue with colleagues to encourage research use
- increased confidence in identifying quality research and, for some projects, carrying out research
- increased knowledge of relevant research and capacity to think about changing practices based on this
- feeling empowered to use research.

Longer-term outcomes for the participants (beyond the duration of the project)

- research influences teachers' conceptual thinking
- research is embedded in practice
- research is embedded in teachers' professional identity
- participants disseminate research and approaches to using research to inform practice.

In addition to the outcomes for teachers and schools, the Wellcome programme aimed to support the development of successful, sustainable projects that could be delivered at scale to science teachers. In relation to the wider education system, the intention was to influence policy and practice decision-making by contributing to the evidence-base about how teachers use and carry out research, how this can be supported most effectively, and the impacts of teachers engaging with and carrying out research.[7]

[7] The specific outcomes for Wellcome and the wider education system shown on the ToC are beyond the scope of this study. Wellcome's new strategy, launched in 2020, has moved away from investing in UK science education.

1.4 Study methodology

Overview and research questions

The study team undertook a concurrent mixed-methods study to answer the research questions set out in Box 2, comprising:

- baseline and endpoint participant surveys to measure change-over-time in relation to the intended outcomes and participants' perceptions of the projects at endpoint
- interviews, group interviews, and observations to explore research brokerage and use, and provide explanations for the quantitative findings
- analysis of Management Information (MI) data, collected by the four projects, to identify recruitment and participation patterns.

Full methodological details are presented in Appendix 3.

Box 2: Research questions

Outcomes

- What impact does participation in the projects have on participants' awareness of and access to research, confidence to use research to inform practice, and use of research in science teaching?
- What additional outcomes were achieved for the participants, pupils, their schools, and the wider education system?
- How do the outcomes vary according to the project components and the combination of those components?

Experience and perceptions

- How do participants experience and engage in the projects and enact their learning from the projects in science pedagogical practice?
- What programme and contextual factors support and impede successful impacts and outcomes?

Conceptual/theoretical understanding of research use in science teaching

- What underlying mechanisms are perceived to support positive outcomes (e.g., collaboration, autonomy, changes in professional identity)?
- How can the use of pedagogical research to inform science teaching be conceptualised?

The research was undertaken at the programme level. The effectiveness of individual projects is not assessed. Instead, the exploration of effectiveness focused on the features of research brokerage that were perceived by the participants and project teams to be more or less effective in supporting research use and, in turn, practice change.

Conceptual tools

Drawing particularly on Nutley's (2013) and Weiss's (1979) work on the use of research and adapting it to the context of this study, we defined three teacher research use constructs, as set out in Box 3. These, subsequently, informed the design of the research instruments, outcomes measures, and data analysis.

Box 3: Teacher research use constructs

Accessing and engaging with research

- finding, and engaging with, primary and secondary research sources and research summaries
- judging the robustness of the evidence
- developing an understanding of the research findings.

Translating research to inform practice

- translation by teachers from one or more research source/summary into ideas for science pedagogy or curriculum development, and creation of lesson or curriculum plans, and/or teaching and learning resources
  AND/OR
- selection and adaptation of research-informed resources, such as lesson plans and associated teaching and learning resources, that have already been translated from research by the project teams for use in practice.

In-school research use

- *instrumental:* making changes by implementing research-informed ideas, approaches, and resources in own practice and/or across a team or department[8] – this was the main intention of the Wellcome projects
- *conceptual:* using research and research-informed resources to inform thinking and discussion
- *strategic:* using research to legitimise an approach or persuade others of its value and/or affirm an existing practice.

The varying foci, aims, content, resources, and modes of delivery of the projects offered an opportunity to explore how each of these constructs was enacted and how they were interrelated. We hypothesised that the components would not necessarily occur in a linear sequence, for example - 'accessing' research was not necessarily the starting point, and that teachers would engage with them iteratively.

[8] This includes undertaking trials of research-informed interventions

Methods

Outcome measures

Survey-based outcome measures related to research use and science pedagogy were designed with reference to the research-use constructs outlined above, the research-use literature, NFER's Research Engagement Measurement Survey (Nelson et al., 2017) and the EEF's *Improving Secondary Science Guidance Report* (Holman and Yeomans, 2018). Full details of the survey design can be found in Appendix 3.2.

Baseline and endpoint participant surveys

The surveys, which were administered to all programme participants, aimed to measure change over time in the research use and science pedagogy outcome measures for all participants similarly, despite the differences between individual projects' foci and approaches. The endpoint survey included a small number of project satisfaction questions. Administration was staggered to fit with the projects' differing delivery timelines; the baseline survey was conducted before the participants received input from their projects and the endpoint survey was conducted after each project ended.[9] The participants' views of their projects were also collected at endpoint. One hundred and ninety-eight of the participants (52% of the baseline respondents) were matched to endpoint respondents and entered into the change-over-time analysis.

Quantitative factor analysis was undertaken on the baseline survey results to create composite research use and science pedagogy outcome measures. Changes in these measures (and some individual items) between baseline and endpoint were then explored at programme level using a t-test to examine their statistical significance. A basic descriptive analysis was conducted on the endpoint project satisfaction questions. Full details are provided in Appendices 5 and 6.

Management Information (MI) data

To explore recruitment, retention and participation patterns, retrospective attendance and engagement MI data were collected from each project, in relation to each of their participants, at the end of each term. Data were collected from each project at either two or three time points, depending on the duration of the project. Basic descriptive analysis was undertaken to explore participants' characteristics, levels of engagement, and retention.

[9] To maximise response rates, the surveys for all projects were administered for completion by the end of the summer term 2021. The Teacher-led RCT project delivery continued until October 2021, so the data collected are not aligned with the project endpoint.

Interviews, group interviews, and observations

Qualitative methods were used to gather data from participants and project teams on their project experiences and the outcomes that they perceived to be related to their participation. The aim of this was to deepen understanding of how science teachers use and/or carry out research and the types of support that are most effective for this, as well as offering explanations for the observed quantitative outcomes. Generic research instruments were designed using the study conceptual tools and tailored for use in each project. The project resources were also reviewed. Table 1 summarises the qualitative data collected. The number and timing of the data collection activities was tailored to the scale and nature of each project (see Appendix 3.3).

Table 1: Summary of achieved qualitative data collection

Data collection activity	Total number	Unique participants
Project leaders and team members - longitudinal semi-structured interviews or group interviews	16	19
Participants - longitudinal semi-structured interviews	36	17
Participants - endpoint only semi-structured interviews or group interviews	44	80
Semi-structured observations of project delivery	12	N/A

Qualitative data analysis was undertaken using an adaptive theory approach (Layder, 1998), which combined deductive analytical approaches with inductive analyses to enable theory to both to shape and be shaped by the data generated by this project (Appendix 3.3).

Chapter 2: Project design and recruitment

Chapter 2 draws on analyses of MI and qualitative data to present findings on:

- the aims, structure and target participants for each of the four projects that comprised the Wellcome programme
- achieved recruitment, participants' motivation for joining the projects, the projects' recruitment strategies, and the enablers and barriers to recruitment.

2.1 The projects

This section provides an overview of the projects' aims and objectives, plans for delivery at the outset, and any changes that took place during implementation. Each project developed a ToC prior to implementation, which can be found in Appendix 2.

Table 2 summarises the key features of the projects by project lead, participant type, intended school phase, and participant numbers.

Table 2: Project Summaries

Project	Participant type	Participant phase	Target number of participants
Journal Clubs	Teachers Teacher facilitators to lead the Journal Clubs	Primary & secondary	288 teachers (clustered across 24 online Journal Clubs – approx. 12 teachers per club) 24 Journal Clubs facilitators
Research-2-Practice	Trainee teachers ITE mentors	Primary & secondary	90 trainee teachers 90 mentors
Evidence in Action	Teachers	Secondary	80 teachers (clustered across 20 schools – approx. 4 per school)
Teacher-led RCTs	Teachers	Primary & secondary	60 teachers in total

Journal Clubs

The project aimed to establish 24 (eight primary and 16 secondary) online Journal Clubs for teachers, each consisting of approximately 12 teachers, to run over the course of 18 months. It was planned to support this by recruiting and training experienced science teachers to undertake the role of facilitators.

The aim was to encourage the acquisition of research literacy skills, help the participants keep up to date with subject-related research literature, and support reflection on research findings and how they could be incorporated into practice. The creation of communities of teachers to share ideas and strategies was a key desired project outcome. The design of the Journal Clubs was informed by the key features of effective CPD outlined by Cordingley et al. (2015), as well as the key features of effective teacher learning communities, identified by Speckesser et al. (2018). The project focused on engaging teachers with academic and professional journal articles and planning for research use in school.

Both the facilitators and Journal Clubs participants were required to undertake self-directed online training, consisting of an introduction to the theory, aims, and structure of Journal Clubs, and research appraisal skills for different types of articles - literature reviews (systematic and non-systematic), meta-analyses, and quantitative and qualitative papers. The training introduced three Critical Assessment Tools (CATs), one each for systematic reviews, RCTs, and qualitative research, to be used to prepare for and during Journal Clubs. There was also a Classroom Implementation Tool (CIT) to aid the planning and implementation of learning from Journal Clubs in school and reflect on implementation. Training was released as Journal Clubs progressed through the different types of literature.

To support facilitators during the early stages of the project, they took part in Journal Clubs led by two Chartered Teachers[10] recruited specifically for this purpose. The Chartered Teachers modelled Journal Clubs facilitation.

The facilitators used a planning and reflection tool to prepare for, and reflect on, each Journal Clubs session. The Journal Clubs participants were provided with access to academic and professional articles. Every Journal Clubs meeting was split into three parts. The first focused on reflecting on the degree of success of the implementation of the previous Club's learning in practice; the second discussed the current paper, supported by the relevant CAT tool; and the third focussed on planning and discussing the next steps in terms of taking learning into the classroom, using the CIT.

The Journal Clubs articles were chosen to span different methodologies and types of article to enable the participants to gain experience of appraising different forms of evidence. Of the eight Journal Clubs meetings delivered (see below re: reduced number of sessions), three articles were related to the question of guidance versus minimal instruction in inquiry-based learning with

[10] Chartered Teacher Status is a professional accreditation that provides formal recognition to highly accomplished teachers who have attained an advanced standard of practice. Chartered Teachers are recognised for evidence-informed, high-quality teaching practice, benefiting their school and the children and young people they teach.

reference to Cognitive Load Theory and the Expertise Reversal Effect. Two articles focused on metacognition and independent learning skills, with one discussing the concept more broadly and the second illustrating it in the context of online searches. Topics for two articles were chosen by the participants as part of the mid-project evaluation - interleaving and practical work - and a further paper was chosen by the Journal Clubs facilitator.

Changes to the Journal Clubs project

Due to the impact of the COVID-19 pandemic, the project was scaled back to eight Journal Clubs sessions, running monthly, and the number of Journal Clubs was reduced to 16 (one primary and the others mixed phase). In contrast to the other three projects, the Journal Clubs project was originally intended to be delivered online; therefore, the delivery format remained unchanged.

Evidence in Action

This project aimed to increase teachers' engagement with and use of research through the provision of adaptable research-informed lesson plans and associated teaching and learning resources. The lesson plans were annotated with brief explanations of the research behind the lesson content, along with hyperlinks to the underpinning research evidence, hosted in three research accessible, teacher-facing research summaries:

- EEF's Teaching & Learning Toolkit
- EEF's Improving Secondary Science Guidance Report (Holman and Yeomans, 2018).
- IOPSpark webpages on student misconceptions[11]

The project rationale was that through using the lesson plans, teachers would engage with and use research by default and that by repeatedly pointing to the same three sources in the lesson plans this would increase the chance that teachers would seek out research on these sites themselves, beyond the module.

Eight lesson plans, each for a one-hour lesson, with an associated slide pack and student worksheet were to be produced for a single topic in Year 7/8 physics - electric circuits - which was identified as challenging to teach.

The project intended to offer three face-to-face training and feedback sessions in host schools, one to be run before the project began and two during delivery. These training sessions were intended to support engagement with the research summaries and use of the lesson plans, as well as increasing teachers' collaboration in terms of encouraging colleagues to use research

[11] The IOPSpark Misconceptions web pages comprise a research-based database of common student misconceptions in physics, for different ages and topics. In addition to describing the misconception, this site points teachers towards associated diagnostic questions and resources for tackling the misconception.

evidence. Each training session was to comprise a half-day workshop, run by the project team. Webinars would be available for those unable to attend in-person events.

The project aimed to send emails to the teachers to remind them to reflect on how they could put research into practice beyond the module, and to prompt them to encourage their colleagues to use evidence.

Changes to Evidence in Action

As a result of the pandemic, all project sessions were switched to online delivery. Four training and feedback sessions were delivered instead of three. As a result of the January 2021 school closures, most of the participant schools delayed the use of the lesson plans until the summer term, but some could not reschedule and used the lessons online in the spring term. Some training sessions were rescheduled, but it was not possible for the training sessions to run alongside lesson use for all schools. The training sessions were available to view online should a participant miss a session.

The lesson plans were created by experienced teachers and researchers. The plans incorporated research-informed resources from IOPSpark physics teaching resource bank and Best Evidence Science Teaching (STEM Learning, no date) and ideas developed by IOP. STEM Learning was contracted to support the delivery of the training sessions.

All lesson resources were made available on the project website.

Research-2-Practice

The Research-2-Practice project was delivered by a collaboration between three universities, and an EEF Research School,[12] together with their associated Evidence Leads in Education[13] (ELEs) and local Specialist Leads in Education (SLEs).[14] The project also employed two Post-Doctoral Research Associates (PDRAs). The project aimed to provide primary and secondary Post Graduate Certificate in Education (PGCE) trainee teachers, undertaking School-Centred Initial Teacher Training, with research summaries and research-informed lesson plans to support their science teaching. ITE mentors were to be trained to support their trainee teacher/s to adapt and implement the lesson plans. The project leaders hoped to bridge the gap between pedagogical

[12] EEF Research Schools are designated to work with other schools to support them in using evidence to improve teaching practices.

[13] ELEs are outstanding primary or secondary teachers, who are middle and senior leaders with the skills to support those in similar positions in other schools.

[14] SLEs focus on developing the capacity and capability of other subject leaders so that they have the skills to lead their own teams and improve practice in their own schools.

research and practice.

The project aimed to produce 60 research summaries and a lesson plan to accompany each summary (30 each for the primary and secondary schools) on science topics identified as difficult to teach, to be hosted on a website. The focus on topic-specific pedagogical research, was in response to the identified lack of subject-specific CPD for science teachers (see IOP, 2020).

The research summaries were to be complied from peer-reviewed research (which is often inaccessible to teachers, e.g., behind a paywall) on the teaching of the topic. Feedback and reflections from users were to be used to improve the resources.

The intended project phases were to:

- identify topics in science that experienced teachers (SLEs and ELEs) find challenging
- source academic articles on teaching each topic, and collate a short summary of the research and the specific pedagogical approaches to teach the topic – to be done by the PDRAs
- develop exemplar lesson plans, based on the research summaries - to be done by experienced teachers (SLEs and ELEs)
- train primary and secondary ITE mentors to use the research summaries and lesson plans with their trainee teachers - four primary and one secondary training sessions were to be held
- pilot test these and adapt them as necessary
- arrange final, face-to-face sessions with the mentors.

By focusing on trainee teachers, who are at the beginning of their teaching journey, it was hoped that the emphasis on research would have a greater impact on their practice than might be the case for more experienced teachers, and that this might be sustained. The training of mentors was to be provided by the Head of the Research School and focused on instructional coaching methods.

Changes to the Research-2-Practice project

The number of research summaries was reduced to 40 (20 primary and 20 secondary) because of the pressure of the COVID-19 pandemic. In addition, the training sessions moved to online delivery, with the project offering two separate online training sessions to primary and secondary mentors. Much of the focus of these sessions was around the instructional coaching model as well as anticipating how the project resources might be used. The project resources were not available to participants until summer term 2021 (some were released in May, the others later in the term). During the recruitment process the target group was extended to third year undergraduates from one of the universities.

The intended PDRA visits to trainee teachers and mentors to support their use and understanding of the summaries and lesson plans, and to gather any feedback did not take place because schools were closed to visitors. The final face-to-face session with mentors did not take place for the same reason.

The lesson plans and summaries are hosted on the project website.

Teacher-led RCTs

The Teacher-led RCTs project aimed to train teachers to carry out small-scale RCTs in their own context and, as a result, increase their evidence-based practice, behaviours, knowledge, and beliefs. This approach is based on a clinical practice model, which aims to give voice and agency to teachers and generate evidence to inform practice by undertaking a meta-analysis of teachers' RCT results. The approach has been used in a range of other projects (e.g., Churches et al., 2020a and 2020b).

The project comprised two modules:

- *Module A*: Designing and doing your research project – including the pedagogical focus, writing a protocol, types of data, outcomes measures and ethics
- *Module B*: Analysing and writing up your results – using StatsWizard (the online data analysis tool provided by the project), writing conclusions, sharing the results, and planning for replications.

Module A was intended to refresh science teachers' prior knowledge of the scientific method and support them in developing a trial protocol. The protocol was to be checked by the project team and feedback given. Module B focused on the analysis of trial data and write-up of the findings. The StatsWizard tool was intended to provide a quick, simple way for teachers to analyse their data. The participants were to complete a research poster, using a provided template, summarising their research design and findings, and present this at a final conference. The recommended trial foci for primary teachers were developing science capital, talk for learning and paired/group work. The recommended foci for secondary teachers were, modeling and explaining concepts, effective practicals', and dealing with misconceptions. Using context was suggested as a focus for both phases. Links to research sources related to these foci were to be provided and participants also expected to also draw on their learning from previous STEM Learning courses that they had attended. There was no expectation that participants would read full academic papers.

The original intention was to offer an initial, two-day residential training course, remote support for research design, a one-day data design and write-up workshop, and a face-to-face final conference. As part of the final conference, it was planned to provide training to the participants on how to support other teachers to carry out replications of their trials. Results from the participants and replicants' trials were then to be entered into the meta-analysis.

All project participants were provided with a copy of Churches and Dommett's (2016) book - *Teacher-led research: Designing and implementing randomised controlled trials and other forms of experimental research* - before the start of the programme as well as access to a comprehensive range of resources to support trial design and analysis.

The trials were intended to be run in schools over a period of approximately four weeks. The teachers were then to be encouraged to support other teachers to carry out replications.

On completion of the project, meta-analyses of the teachers' findings were to be undertaken by the project team, to generate evidence on the impact of the pedagogical strategies and/or resources trialed for wider dissemination.

Changes to the Teacher-led RCTs project

As a result of the pandemic, the mode of delivery was reshaped, and the resources were repackaged to support the revised delivery pattern. The initial training was reduced to two webinars, each lasting two hours. The pre- and post-session tasks, including viewing videos and reading, were intended to cover material that would have been included in the face-to-face two-day training session. The participants were provided with a learning plan that was linked to a Dropbox containing all of the support materials. Protocol development was supported through online drop-ins and one-to-one support. Because participants reached the analysis stage at different times, and many teachers were able to implement their trials during the project lifespan, Module B was delivered through one-to-one online support. The one-to-one support also included support and guidance for teachers on how to undertake replications of their original studies.

2.2 Recruitment

Achieved recruitment and participants' characteristics

Headline finding

- Four hundred and sixty-eight unique participants were recruited (74% of the intended target of 632).

Table 3 summarises recruitment by project. Evidence in Action was the only project to recruit its intended number of participants, and was able to secure more participants than the intended 80. There were four participants who were recruited to two projects within the programme.

Table 3: The recruited participant group by project[15]

Project	N participants recruited	% of intended number of participants recruited	% of total number participants recruited to programme
Evidence in Action	110	138	23
Journal Clubs	208	67	44
Teacher-Led RCTs	38	63	8
Research-2-Practice	116	64	25

Over two-thirds (68%) of the participants were based in secondary schools, with 30% based in primary schools. The participants held a range of job roles– most commonly, they were classroom teachers (35%) or science subject leaders (28%). Less than a fifth of participants were trainee teachers, which is unsurprising as only one of the projects targeted this group. The remaining participants were middle leaders, senior leaders, and newly-qualified teachers (NQTs).

As such, the participants had varied levels of experience – 38% were trainee teachers, newly-qualified, or early-career teachers; 41% had been teaching for 6 to 20 years and 10% for over 20 years. The remaining 11% of the participants did not report their level of experience.

Approximately a third (34%) of participants taught general science, while 24% mainly taught biology, 18% chemistry and 15% physics. However, 9% of the programme participants did not report the main subject taught.

The recruitment data tables are presented in Appendix 4.

Participants' motivations

Headline findings

- The main motivations for joining the programme were the opportunities it offered to improve practice, pupil engagement, and scientific understanding; and to engage with, use and/or carry out research.

Interviewees, who gave a range of reasons for joining their project; some were common across the projects, and others related to the specific aims and objectives of individual projects.

[15] This includes participants recruited to more than one project.

The most frequently mentioned motivation for joining a project was to improve teaching practice, whether it was their own, within their team or department, or across their school. The interviewees mentioned gaining new ideas and strategies for teaching. Some hoped to increase levels of practical work and gather ideas on 'bringing science to life', while others were keen to increase the range of science content available. The physics focus of the Evidence in Action project was particularly welcomed by non-physics specialists, as was the topic area of electricity, which was perceived by interviewees as challenging to teach.

Some interviewees were motivated by a desire to improving students' engagement and scientific understanding, while a few were motivated by raising pupil attainment.

Interviewees were motivated by the opportunities to engage with, use, and carry out research. Motivations reported across the projects spanned a keenness to engage with high-quality educational research: introducing (or, in some cases, reintroducing) research into their teaching, and deepening research use in their school. In addition, Journal Clubs project interviewee were interested in learning *how* to engage with research, with some noting that it was more beneficial to engage with research themselves rather than receive the information second-hand from school colleagues. Some interviewees wanted to set up a journal club in their own school. Research-2-Practice and Evidence in Action interviewees were keen to receive research-informed resources and Teacher-led RCT interviewees wanted to gain an understanding of the research process and evaluate the effectiveness of their practices.

Other reasons given for joining the projects were:

- accessing a science and/or subject-specific CPD opportunity
- developing science subject knowledge
- being able to speak to, and network with, other teachers, particularly where the teacher was the sole science or subject specialist in their school
- supporting ITE students' practice and research access (for Research-2-Practice mentors).

Baseline survey data (see Section 5.2) and the qualitative findings both indicated that most participants were committed to research use before starting their project. However, the qualitative data indicated variation in the value placed on research, and the extent of research use, in participants' respective schools.

Project recruitment strategies

As shown by Table 4, the four delivery projects used a range of recruitment strategies.

Table 4: Project recruitment strategies

	Journal Clubs	Evidence in Action	Research-2-Practice	Teacher-led RCTs
Existing contacts e.g. mailing and membership lists	✓			
Social media	✓	✓		
Via universities' PGCE courses and associated schools			✓	
Teachers who had attended STEM Learning courses				✓
Recruitment of entire departments		✓		
Telephone calls to schools		✓		

Factors enabling recruitment

Headline finding

- Recruitment was aided securing senior leader buy in; having a simple sign-up process; and schools and teachers' pre-existing commitment to research use.

The Evidence in Action project recruited schools rather than individual teachers. The project lead's rationale was that this model required senior figures in schools to buy into the project, which would make staff engagement and subsequently, the use of project resources, more likely. The over-recruitment for this project indicates that this was a successful strategy.

Participants noted the ease of signing up to some of the projects as being positive; for example, '*It was literally an email. I replied saying yes please, they* [said] *ok brill, we will be in touch and then they emailed with the programme and the dates'* (Teacher 2, Teacher-Led RCTs).

In-school support for research use was indicated to be an enabler, particularly if the leadership team or headteacher was positive about research being used to inform teaching:

> *They want the school to be more and more forward-looking research-based school, so they were completely behind us… wanted to know how it was going, wanted us to evaluate it, you know, very supportive SLT.* - Teacher 3, Evidence in Action

Similarly, where teachers were already committed to research-use, recruitment was easier.

Factors impeding recruitment

Headline findings

- The main challenge to recruitment was pressure on schools due to the COVID-19 pandemic. A lack of clarity about project expectations was also reported as a barrier.

This section relies on the perceptions of project teams and teachers who had been recruited by the projects. As data was not collected from teachers who did not or could not join projects there may be factors impeding their recruitment that were not captured in this study.

Unsurprisingly, the COVID-19 pandemic and its knock-on effects in schools were the most significant barrier to recruitment. One project that recruited participants prior to the pandemic suffered drop-out before it started and, despite re-recruitment efforts, this project began delivery with below its target number of participants. The remaining projects, which recruited participants in autumn 2020, found recruitment even more challenging:

> *This has been the hardest project I have ever worked on in terms of recruitment. It's not because of the nature of the project, the feedback I've had from speaking to heads of science, head teachers, is the project sounds really exciting, its COVID-19. It has made things exceedingly difficult.* - Project Leads Interview 1, Research-2-Practice

Project leaders noted that engaging in external projects, however interesting, was not a priority for schools and teachers that were already struggling to manage teaching and learning activities during the pandemic. Teachers and schools had to prioritise their existing workloads and the need to implement '*catchup curriculums*' meaning that they had less capacity to engage with external projects and activities, with workloads already higher than normal.

The inability to recruit participants face to face, because of the pandemic, was mentioned as an issue in one project and, in addition, project leaders were reluctant to push for participation at a time when teachers were already overloaded:

> *So I think we could've pushed a bit harder* [in terms of recruitment] *on some teachers but we haven't, because it's not the right thing to do.* - Project Lead, Teacher-led RCTs

Some interviewees thought there was a lack of clarity about what the projects might involve or when they would start; for example, one ITE student noted: '*I think the whole process wasn't very clear'* (Trainee teacher 1, Research-2-Practice) and a participant in the Teacher-led RCTs project stated '*I think the only thing missing* [from the communications] *was maybe like a date given … because I think, for a little while, I was kind of, like, have I missed an email? Do I know what's coming?*' (Teacher 2, Teacher-led RCTs). Setting clear expectations about project timescales and what participation would mean for both teachers and schools, for example in terms of teacher time, was perceived as important.

Summary of Findings

The programme recruited 468 unique participants across the four projects, which was approximately three-quarters of the intended target. Most recruited participants were based in a secondary schools and specialised in one of the three sciences. Participants across both phases had a range of job roles and varied levels of teaching experience, and just over a quarter had a science leadership role.

The main motivations for signing up to projects were improving practice and student engagement with and understanding of science, as well as a desire to engage with or carry out research. Recruitment was enabled by the existing teacher/school buy-in to research use, a simple project sign-up process, and whole-school sign-up strategies. The most significant barrier to recruitment was COVID-19, and the resultant pressure on teachers and schools. A lack of clarity of expectations was also mentioned as a barrier.

Chapter 3: Brokering, using and doing research

Chapter 3 draws on the participant and project team interviews, and observations of project delivery, to present in-depth accounts of:

- the implementation of project-level brokerage
- how the participants engaged with project-led brokerage, went about engaging with, using and/or carrying out research, and brokered research in their school.

3.1 Overview of research brokerage

Brokerage spans the activities, resources, and motivations within which pedagogical research is exchanged, transformed to inform practice, and otherwise communicated (see Section 1.4).[16] As previously noted, research brokerage was led by the project teams at the project level, and by participants within their schools.

We analysed the qualitative data to explore brokerage in the Wellcome programme. The three constructs of teacher research use defined in Section 1.4: access and engagement; translation of research to inform practice; and in-school research use (including carrying out research) were used as overarching analytical categories to organise the data. Key themes were then identified inductively within each category.

The focus of research brokerage differed across the projects, in line with each project's aims. Table 5 presents a summary, from the interview and observation data, of the brokerage activities that the different projects implemented in relation to accessing and engaging with research, translating research to inform practice, and in-school research use.

[16] Adapted for this study from Farley-Ripple et al., 2017.

Table 5: Research brokerage activities implemented by the projects

Research use focus	Journal Clubs	Evidence in Action	Research-2-Practice	Teacher-led RCTs
Support to accessing and engage with research **(Sections 3.2 and 3.3)**	Provided academic journal and professional articles Online training modules and Journal Clubs activities and CAT tools to support the judging the robustness of the research, and developing an understanding of the findings	The facilitators highlighted the links in the training sessions and project materials to three research summaries: two related to science teaching and one to generic teaching and learning	Produced - from primary research sources - research summaries related to teaching topics that were identified as difficult-to-teach Research summaries provided to the participating mentors and trainee teachers	Provided Google doc evidence summaries on suggested pedagogical foci for RCTs Access to evidence from prior STEM Learning courses If requested, 1:1 support to access and/or engage with the research to support trial design
Support to translate research to inform practice **(Section 3.4)**	Participant translation facilitated in Journal Clubs and supported by CAT and CIT tools	Translated by the researchers and experienced teachers into lesson plans and associated resources Breakout groups in workshops for participants to discuss adapting the lesson plans and resources to suit their context	Research summaries created by PDRAs and translated by, SLEs and ELEs into lesson plans. Trainee teachers intended to work with their mentors to adapt these to suit their context	Participant-led translation to inform the design of the intervention trialled. The project team checked the project protocol produced by the participant, and support was offered if necessary
Support for in-school research use/ carrying out research **(Sections 3.5 and 3.6)**	Facilitated discussions in Journal Clubs about planning for implementation and reflection after use, supported by CIT tool	Short gap tasks to think about implementation. Facilitation of discussions about in-school implementation during the training sessions	Mentor training, including instructional coaching, provided to prepare mentors to support trainee teachers to prepare for, and reflect on, in-school implementation	Trial design supported during the training sessions and one-to-one support. Feedback provided on the trial protocol. One-to-one support for trial analysis using the StatsWizard spreadsheet provided

3.2 Accessing and engaging with research

Headline findings

- Most of the interviewees only accessed, and therefore, ultimately, only used in school, the research provided by their project team. Depending on the project, the research provided varied in terms of the form, pedagogical foci and balance between topic-specific, science and generic pedagogical research.
- The nature and depth of participant engagement with research varied significantly by project, in line with the differing project aims, the nature of the research provided, and the emphasis that the project team placed on research engagement.
- Engagement also varied between individuals within the same projects. Depth of engagement was generally associated with perceived relevance to practice.

Accessing research

Table 5 and Section 2.1 set out the research sources that were provided to participants in each project. The finding that few project participants in the Journal Clubs, Research-2-Practice and Evidence in Action projects accessed research sources beyond these is unsurprising, as support to locate other research sources was not a key focus of any of these projects. It is, however, an important finding. As the findings presented in this chapter show the nature of the participants' engagement with research and, ultimately, what research was used in schools, was influenced by the project teams' decisions about the pedagogical focus of the research, what counted as 'robust evidence', and the format of the evidence (e.g., papers or research summaries).

In the Teacher-led RCT project participants only accessed research that was relevant to the intended focus of their trial. Observations of the training found that the project team made connections to research sources that were relevant to individual trials during breakout discussions and encouraged participants to contact STEM Learning colleagues for further links to research. Some interviewees concerning requested support to access research, but not all. Those who did tended to report contacting a colleague who they knew through their prior engagement with STEM Learning courses. Some interviewees undertook their own Google searches or accessed resources they were already familiar with; for example, ones they had used during their teacher training or that were being used in their school. The Teacher-led RCT interviewees tended to access a more range of diverse sources of research than interviewees participating in the other projects. This included books and blogs, as well as papers and research summaries.

Engaging with research

Engaging with research, in this study, spans judging the robustness of the evidence and developing an understanding of the research findings (see Section 1.4). This was a key focus of the Journal Clubs activity. During the Journal Clubs sessions, the facilitators were observed to provide structure and space for discussions that progressed logically through the key questions in the CAT tool on the validity, trustworthiness and relevance of the research. The process of engaging with journal articles was often described by interviewees as time-consuming, although this was reported as becoming easier over time. In addition to assessing the quality and relevance of the research, engagement was reported to involve developing an understanding of the terminology:

> *I think I spent more time researching the research of the articles than actually reading the articles and applying the CAT assessment… trying to understand what the technical terms mean… in a classroom... we'd have one meaning, but to an educational psychologist it would… mean something completely different.* - Group Interview 8, Journal Clubs

Some of the interviewees welcomed the structure and guidance provided the CAT tools, and most interviewees' accounts demonstrated that they engaged in a structured, careful consideration of at least some of the papers:

> [in a couple of papers] *we weren't sure about the sample size.* [In] *Another one... we were not convinced that the selection of potential* [participants] … *would be mirrored in* [our] *school environments ... Therefore, we weren't too sure whether... if we then tried to apply that to our setting, whether it'd work or not.* - Teacher 5, Journal Clubs

In contrast, most Evidence in Action interviewees described engaging with research 'snippets' or 'nuggets' extracted from the research summaries. Observations of the training found that, while links were made by the facilitators to the evidence summaries, the participant discussions during the sessions focused almost exclusively on the lesson design rather than the research evidence. Nonetheless, most interviewees reported that they had engaged with the research summaries themselves, and felt very positive about ease of access and, as the project leader noted, the '*easy-to-reap rewards*' of the approach. The interviewees also appreciated the fact that the research had already been 'vetted' and selected for relevance to practice, enhancing the ease of access:

> *It's given me a better way of accessing... research. …being able to have the websites and the links that they've provided for us that lead us towards where the research is, that's already vetted, it's already checked, it's looked at in terms of how much they think it's going to support your teaching. …means that I've a place to go where I know I'm going to find something useful as opposed to heading out blind and thinking, well, I might find something useful after a couple of hours, but it's a couple of hours that I don't have.*
> - Teacher 6, Evidence in Action

There was very little interview evidence to suggest that engagement with 'snippets' led to in-depth engagement with research. There was, however, notable enthusiasm amongst the Evidence in Action interviewees about using the EEF and IOP summaries in the future. It was beyond the scope of this study to be able to identify any differences in effect between in-depth engagement with research and engagement with 'snippets' of research.

Due to the late distribution of their research summaries, many of the Research-2-Practice interviewees were unable to comment on how they had accessed and engaged with the research.

The participants in the Teacher-led RCT project, in contrast to those in the other projects, only engaged with research in the earlier stages of their project, when designing their trial intervention. There were few reports from these interviewees of taking up the offered one-to-one support for engaging with research. Assessing the quality of the evidence was not a focus of the project and only one interviewee highlighted the need to find 'credible' evidence. The participants' trial protocols were checked by the project team to ensure that their intervention had an evidence base; if not, feedback and support were provided.

Within each project, there was variation in the depth to which the individual interviewees engaged with the research, from close reading to very light skimming. A few of the interviewees did not engage at all with the research provided. Depth of engagement was generally linked by the interviewees to their perceptions of the relevance of the research to their practice.

3.3 Translating research to inform practice

Translation of research by participants into ideas and resources for teaching was found to be a core focus of the Journal Clubs project and a secondary focus of in the Evidence in Action project. Research-2-Practice and Evidence in Action translated research for participants into research-informed resources, and participants in these projects undertook further translation work as they adapted these resources for their school context.(see Table 5 and Section 2.1 for further detail). Participants in the Teacher-led RCTs project translated research as an integral part of their trial design, the findings on this are presented in Section 3.5.

Translation by participants

Headline findings

- Engaging with and translating research were highly inter-related processes.
- Following the selection of a research source/s that resonated with a practice 'issue', translation was an iterative process of using the research to think through the 'issue' and work out ideas to inform practice and/or create resources.

- Structured discussion and questioning by facilitators, the use of critical appraisal and critical implementation tools and the sharing of professional experience with research-interested colleagues during projects appeared to support participant-led translation.
- Translation was shaped by the participants' school context.

In the Journal Clubs project, the processes of engaging with research and translating it to inform practice were integrated. Interviewees reported that the completion of the CAT and CIT tools supported both aspects of research use. Journal Clubs were observed to create a space that assisted exploratory discussion and sharing of participants' understanding. Translation was enabled by the facilitators structuring engagement with the tools, as well as the use of careful questioning. Facilitators were able to keep the discussion flowing and ensured that participants had an opportunity to raise points and questions.

In line with the Evidence in Action project's aims, a lighter-touch approach was taken to supporting participant-led translation, through optional gap tasks and reflection. The gap tasks asked participants to engage with a short snippet from one of the research summaries provided, answer a simple multiple-choice question to assess their experience of using the principle in practice, and an optional question on how they could best integrate the research into their practice. Observations of the training found limited evidence of discussions on ideas to inform practice emanating directly from the research summaries. However, many of the Evidence in Action interviewees reporting that they had done this, as exemplified below:

> [as an] *experienced non-specialist, the IOPSpark materials were the most useful thing for me, aside from... all the work with the [provided lesson plans and power points], the IOP stuff was the bit that then informed my questioning which allowed me to more effectively* [know] *where my students were at and what thoughts they had in their head.* - Teacher 1 Longitudinal Interview, Evidence in Action

There were some commonalities across the Journal Clubs and Evidence in Action interviewees' accounts of translating research. Interviewees described 'thinking things through', 'reassessing', and 'factoring research into planning'. For some, in both projects, the purpose of translation was to develop or refine lesson plans or resources. For others, it was a broader consideration of a pedagogical approach, such as when and how to use practicals or scaffold learning. In some instances, translation was undertaken with the intention of refining the interviewees' own practices. In others, particularly when the interviewee was a middle or senior leader, it was to develop departmental (secondary) or whole school (primary) practices.

Accounts from Journal Club interviewees consistently indicated that there were three key components within the translation process:

1. selection of a specific paper, or papers, which resonated with a practice issue previously identified in their own, their department's or their school's practice
2. drawing on the ideas in the paper to help them 'think through' the practice 'issue'
3. working through how the ideas from the research could be used to develop practice either generally, in relation to pedagogical principles, or specifically, for example in the design of a lesson plan or resources.

Components 1 and 2, and, in some accounts, component 3, were also evident in Evidence in Action interviewee reports, when they had undertaken participant-led translation. While component 1 triggered the initial motivation for translation, components 2 and 3 were usually described as being undertaken iteratively.

The importance of resonance to a practice issue (component 1) as a motivation for translation was highlighted in one Journal Clubs group interview:

> [I was in] *pharmaceutical research for quite a few years, before I trained to be a teacher. …I particularly enjoyed that article …, because I think as scientists, we want to use practical work but I think sometimes, practical work isn't used to its best advantage and what the students actually learn from it and what we think they learn from it, I think are sometimes very different things.* - Group Interview 7, Journal Clubs

It is of note that the interviewees rarely started translation by reviewing their practice and identifying and 'diagnosing' a 'problem' to be addressed. Rather, when a paper or research summary 'snippet' was presented to them by the Journal Clubs facilitator or Evidence in Action project team, that triggered a focus on the issue. Few interviewees mentioned that this had prompted them to explore the issue itself in greater depth or seek out more research on the issue. This approach is to be expected, as it was aligned with the projects' structures and activities. In addition, the project teams had already selected research that was likely to address issues commonly encountered in science teaching. The approach does, however, run contrary to implementation science research and guidance (e.g., Sharples et al., 2019), which highlights the importance of undertaking an in-depth 'diagnosis' of the 'issue', drawing on a range of school and external evidence, in an extended exploratory phase.

Translation was not necessarily a linear process from a single paper or snippet from a research summary to practice. Some Journal Clubs interviewees reported merging translation from several papers to address one practice issue.

The Journal Clubs interviewees highlighted the value of engaging with and drawing on the knowledge and professional experiences of other research-interested teachers attending the club during the translation process:

> *Actually, then saying, oh well, have you thought about trying this, you could take this bit of research and try doing such and such with it' and there've been a few of those sort of light-bulb moments where we've been able to really pick apart –'this is what it says, how is it relevant and how can I try to experiment with this in my own classroom?'… So that's been really, really helpful for me, to see how other people have done it and, and to get their ideas.* - Group Interview 9, Journal Clubs

Engagement with theory, and reflection, were reported as supporting translation by a few of the interviewees:

> *It starts you talking about the theory and it becomes part of your language and your conversations, so with that builds confidence.* - Teacher 3, Evidence in Action

> *That article in particular made me... reflect a lot on when you're doing practicals and how you develop them over the course of… teaching a topic…* [and] *that made me reflect on how I structure my lessons.* - Group Interview 8, Journal Clubs

School context was also reported as important in shaping translation:

> *What I found really interesting was that the other person that came to most of the groups, her setting was very, very, different and so the way that she was interpreting and using a lot of it was very different to the way that I would and the things that we were going to trial were very different as well.* - Group Interview 7, Journal Clubs

Translation by projects

Headline findings

- Bringing together researchers and experienced teachers to translate research into research-informed resources for the project participants was, at times, challenging.
- On occasion, fidelity to the research was reduced as the experienced teachers drew more heavily on their preferred approaches than the research evidence.

As advocated in the knowledge mobilisation literature (e.g., see the Research-Practice partnership literature, such as Henrick et al. (2017)), the intention in the Evidence in Action and Research-2-Practice projects, was to co-create research-informed resources for project participants by drawing together research and professional expertise. The respective approaches to translation in the two projects are summarised in Table 5 and Section 2.1.

However, as found in other studies (see Section 1.4), some difficulties were encountered in achieving productive co-construction across the research/practice boundary. Research-2-Practice project interviewees, in particular, highlighted a number of challenges. In part, this may reflect the scale of the translation activity undertaken in this project and the effects of the COVID-19 pandemic, which the project team reported limited the time for expert teachers to engage in translation and meant that the PDRAs could not visit schools.

While some of the translation challenges encountered, appeared to be procedural, they also raise more fundamental questions about the relationship between research and practice.

Communication and collaboration

In the Research-2-Practice project, limited communication between the PDRAs and SLEs/ELEs, the absence of opportunities to work collaboratively across the research/practice boundary, uncertainty about their respective roles, and limited access for SLEs/ELEs to the underpinning research were reported by the SLEs/ELEs to have impeded their work:

> *We can't go to the* [PDRAs]*… to say 'why have you done it like this?' I couldn't ask the question I needed to ask until after I'd submitted my lesson plan last time…. There is no collaborative back and forth.* - SLE Group Interview, Research-2-Practice

The SLEs/ELEs perceived that the PDRA's more limited understanding of school practice and – during the early stages of the project – the inconsistent and variable quality of the research summaries made translation difficult. For example, they reported that some research summaries were not well aligned with National Curriculum requirements; required significant adaptation from the schooling context in another country or different school years; and/or did not take into account the practicalities of in-school implementation, such as health and safety restrictions. Had the PDRAs been able to observe participants using the plans in school, as was originally intended, they may have developed a better understanding of the school context.

As discussed in relation to fidelity below, some of the SLEs/ELEs' perceptions of the research summaries may have been influenced by their long-held beliefs about effective teaching.

Fidelity to the research

The Research-2-Practice project leaders reported some concerns about fidelity to the research in the lesson plans produced by the SLEs and ELEs, noting that these experienced teachers found it difficult to adopt ideas from research when these contradicted their long-standing beliefs about effective teaching:

> *... an experienced teacher will construct a lesson plan drawing on what they've got in their own head about effective teaching. I'm not that sure now that many teachers go to the research literature and distil from the findings of the research a lesson plan. And I think they found that difficult… it was much more problematic than we had envisaged.* - Project manager interview, Research-2-Practice

An attempt to address this issue by giving the PDRAs responsibility for producing tightly-structured, 'skeleton' lesson plans, and limiting the input of the SLEs/ELEs was unsuccessful and was dropped. The SLEs/ELEs considered that, without their expertise, the lesson plans would not be aligned with good practice in lesson planning, and would fail to meet the needs of the trainee teachers and their pupils:

> *What is my role exactly? because this doesn't seem like I'm using my skill as a teacher to add any value here. We haven't been given the freedom to use our nous to interpret that research summary in a way that's going to be dead useful to a trainee teacher.* - SLE Group Interview, Research-2-Practice

As the quotation above also illustrates, the SLEs/ELEs were particularly concerned to use their expertise to scaffold trainee teachers' learning.

Research 'in scope' for translation

The Research-2-Practice research summaries focused exclusively on research on teaching a particular topic. As noted earlier this was to address the deficit in subject-specific support for teachers (IOP, 2020). However, the SLEs and ELEs considered that broader science pedagogical research, for example on delivering practicals, and generic pedagogical research, particularly in the cognitive sciences field, also needed to be considered. They compensated for the absence of this wider research evidence in the research summaries when they constructed the lesson plans by drawing on the approaches recommended in the EEF Improving Secondary Science Guidance Report (Holman and Yeomans, 2018) and looking for misconceptions that had been omitted. The project team perceived this differently, reporting a general concern that the SLE/ELEs were prioritising cognitive science research over the project's intended focus on topic and subject research.

Translation in the Evidence in Action project did include broader science and generic pedagogical research (mainly from the two EEF research summaries), with some topic-specific research from the IOPSpark misconceptions database, but overall focused less strongly on subject-specific research. The Best Evidence in Science Teaching resources (STEM Learning, n.d.) were also brought in to support the translation process.

While there are insufficient data from this study to make any definitive claims, there are tentative indications that drawing together these different types of pedagogic research in the translation process is more likely to support the creation of effective research-informed resources.

Type and range of research-informed resources produced

The findings from both projects indicate that translation is more effective when a package of resources is produced that combines lesson plans with the associated resources, such as slide packs, student worksheets and instructions for practicals. In addition, translation appears to be more effective when the resources are designed for a sequence of lessons rather than individual lessons and target a specific year group. As the Research-2-Practice SLEs/ELEs observed:

> *The difficulty we have was it being a standalone lesson. ...A lot of the best practice as suggested by the [EEF] guidance report, you've got to have that revisiting, you've got to have that checking that they've really understood and that prior knowledge and one standalone lesson isn't really enough.* - ELE Group Interview, Research-2-Practice

Interviewees also pointed out that the extra work that was needed to integrate a single lesson into a curriculum plan and source or create their own resources (see Section 4.3).

The valuing of knowledge from research compared to professional knowledge

Some of the tensions evident in the findings above, and the differing perspectives on how to go about project-led translation, may, to some extent, be explained by interviewees' differing beliefs on the relative value of research and professional knowledge. In line with the Research-Practice Partnership literature, there are tentative indications that translation is more effective when equal weighting is given to both. As Sharples (2013) points out:

> [Research-informed practice] *is about integrating professional expertise with the best … research to improve the quality of practice. It is important to remember that there is a huge amount of experiential knowledge that is not captured by research, and, therefore, that an absence of* [research] *evidence certainly does not mean absence of effectiveness (p7)*

Box 4 draws together learning from the findings about effective translation by CPD providers.

Box 4: Learning about effective project-led translation of research to inform practice

The findings of this study indicate that effective translation is more likely to occur when:

- equal weight is given to both researcher and teacher knowledge
- clear expectations are set out for researchers and teachers
- training is provided that includes challenging expert teachers beliefs about effective teaching and developing researchers' understanding of the school context
- there are regular opportunities for communication and collaboration between researchers and teachers - to share knowledge about the research and school contexts, and interact during the process of resource creation
- translation brings together topic, subject-specific, broader science-specific and generic pedagogical research
- any lesson plans produced are designed for a sequence of lessons, targeted at a specific year group, and accompanied by teaching and learning resources.

Selection and adaptation of research-informed resources

Following the project-led translation of research, project participants undertook further translation of the research, as they adapted the research-informed resources produced by their project team for use in their school context.

Headline findings

- ➢ Research-informed resources were selected when there was a fit between the topic and the scheduling of the participants' curriculum.
- ➢ Participants were expected to, and did, adapt the research-informed resources - adaptations were made to lesson sequencing, structure, assessment, science vocabulary and supporting resources.
- ➢ Reasons for adaptation were teacher judgments and preferences, and to match the pupils' needs and school requirements.
- ➢ Discussion in project workshops and with school colleagues, and mentor support, all helped to shape the adaptations.
- ➢ The question of whether the adaptations might compromise the fidelity to the research, and so lead to less effective practices did not appear to be considered.

This section explores the ways in which the Evidence in Action and Research-2-Practice interviewees selected and adapted the research-informed resources provided. This was facilitated in breakout discussions in the Evidence in Action workshops and by the ITE mentors in the Research-2-Practice project. See Sections 4.3 and 4.4 respectively for participants' perceptions. Some Evidence in Action participants reported collaboratively adapting resources with their in-school colleagues.

Interviewees indicated that selecting a lesson plan and, if appropriate, its associated resources was determined by whether the topic matched the planned curriculum in their school. The intention in both projects was that participants would adapt the research-informed resources to their school context and pupils' needs, indicating that these projects were brokering 'intelligent adaptation'.[17] Interestingly, the Evidence in Action project manager reported that they had to reassure some of the participants that adapting the plans was acceptable and intended.

The main types of adaptations reported by the interviewees were:

- revising the sequence of lessons and/or the lesson structure
- making changes to the assessment
- redesigning the supporting resources, particularly for pupils with English as an Additional Language (EAL) and with Special Educational Needs and Disabilities (SEND); and/or in the Research-2-Practice project, creating or sourcing supporting resources
- occasionally changing scientific vocabulary.

The main reasons given by interviewees for making these adaptations coalesced around:

- the exercise of professional judgement and personal preferences - it was unclear whether personal preferences were research-informed
- accommodating pupils' needs, particularly the need to create resources in formats suitable for pupils with SEND
- matching the school's requirements, such as the need to use given lesson structures and aligning with the whole-school resource design and teaching approaches.

There was little evidence to suggest that the interviewees were adapting the lesson plans and resources to fit the National Curriculum, exam board specifications, or perceived Ofsted requirements. In the case of the National Curriculum, this is likely to have been because the projects had already mapped the lesson plans to the National Curriculum during the translation process. Meeting the exam board specification and Ofsted requirements may also have been considered by the expert teachers involved in the translation.

The following quotation provides a typical example of the nature of, and reasons for, adaptation:

[17] Intelligent adaptation is tweaking research-informed approaches, interventions, and/or research-informed resources to fit a school's context while ensuring that fidelity to the underpinning research principles is maintained

> *We have particular ways that we structure our lessons... any resource was… modified to fit that structure for our school and our students. …there was a slight tweaking of the ordering of the sequence. …we tweaked [the assessment] quite a bit… We… tweaked the resources to sui ... the way that we teach science, which is… consistent across the whole year… and… school.* - Teacher 10, Evidence in Action

Some of the interviewees' accounts of adaptation described how their or their school's views led them to make decisions that appeared to contradict the research they had engaged with; for example, in relation to the research evidence on cognitive load, several interviewees recounted instances where they had chosen to include vocabulary and concepts that were unnecessary at that stage in the National Curriculum.

Insufficient data exists to assess whether the teachers who adapted research-informed resources in ways that appeared to contradict the underpinning research were making 'intelligent adaptations', or adaptations that may have led to less effective practices. Interestingly, there was no evidence from the training observations, nor the project team and participant interviews, to indicate that there had been any discussion about at what point adaptations might lead to a loss of fidelity to the core principles of the underpinning research.

3.4 In-school research use

Headline findings

- In-school research use was predominately' instrumental'[18] in intent, in line with the programme intentions. Instrumental use was also found to be integrally bound with 'conceptual use'.
- Participants implemented research through a 'plan, do, review' cycle. This was supported variously across the projects by workshop discussions, as well as gap tasks, implementation tools, and mentoring.
- Easier, faster implementation was reported when the project resources were easy to use.
- Research was used 'strategically' to validate existing research-informed practices, and also by team and department leaders to support pedagogical changes across their team or department.

This section presents the findings on in-school research use during the project delivery period and how this was supported by the Journal Clubs, Evidence in Action and Research-2-Practice projects. Findings on the impact of project participation on science teaching practices and longer-term changes in research use are presented in Chapter 5. For all three projects, the

[18] See the study conceptual framework in Section 1.4 for definitions of instrumental, conceptual, and strategic research use.

boundaries between translation and in-school research use were blurred, particularly as the interviewees reported developing and adapting research-informed resources with their school colleagues.

Instrumental and conceptual research use

Viewing the data through the 'in-school research use construct' adopted in this study, which comprises instrumental, conceptual and strategic use (see Section 1.4), the majority of the interviewees who reported in-school research use described using the research instrumentally; that is, they implemented the research-informed ideas, approaches, and resources from their project into their own practice and/or across their team or department. The predominance of this type of research use is to be expected, as it was a core aim of the three projects. However, reports of instrumental use were nearly always intertwined with conceptual use. In particular, there were reports of changes in the interviewees' thinking about their own and/or their team or department's practices as well as gaining new understanding and vocabulary that enabled them to discuss and change their practices. As this study was unable to observe in-school teacher conversations, it may under-report in-school conceptual research use.

In all three projects, those interviewees that reported implementing research in school use described engaging in a '*plan, do and review'* cycle. This was variously supported by providing space for pre- and post-implementation discussion, the use of gap tasks or a critical implementation tool, and mentor support (see Table 5 and Section 2.1).

In-school research use appeared to be most widespread and speedy when the project provided a package of research-informed resources, which were easy to implement and share with colleagues, as illustrated below:

> *The lesson plans were really good in that it had what we were doing, the research that supported the learning and also it had the PowerPoints to go with that lesson. We found it very easy to use* - Teacher 2, Evidence in Action

A further factor that speeded up the implementation appears to have been recruiting teams or departments rather than individual teachers and providing them with the time during training to discuss in-school implementation with their colleagues. The Evidence in Action interviewees reported that breakout sessions in workshops, where participants were grouped by school, were valuable in aiding implementation planning.

Although the data on mentoring were limited, there were a few examples of instructional coaching supporting research use, as illustrated below, where instructional coaching was combined with the mentor and trainee teacher using the same lesson plans with their respective classes:

> *I did* - [instructional coaching]*... the discussion between the student and myself,... you have to have a focus so she could talk about the activity she was doing* [so] *I was doing the same* [and] *we could compare notes… then across* [our classes]… *we could compare notes and say, how did it work with that set of children? How did it work with* [the other] *set of children?* Mentor 8, Research-2-Practice

In another school, group mentoring was reported to have worked well:

> [the trainee teachers] *were all on board... we had a meeting... I just said choose whichever lesson you want to do… and then I met with them afterwards and… we evaluated the lessons… and any things that they think could be improved on and… how it* [would] *help them when they're ready to start teaching in September.* - Group Interview 2, Research-2-Practice

Strategic research use

Strategic research use, that is, using research to legitimise an approach, persuade others of its value, and/or affirm existing practice (see Section 1.4), was reported by team and departmental leaders, as exemplified below:

> *…going back to the metacognition… sharing resources* [from Journal Clubs] *in that respect, talking about the findings and techniques and conversations, to get... within my department, that… idea of what we're actually aiming for, but then a little bit wider in terms of, well, what's the language we're using, how's it going to work, what have we got to be careful of?* - Teacher 6, Journal Clubs

Research-informed resources curated by a project, were reported to make it easier to engage and persuade school colleagues:

> *The project's made it a lot easier to bring other people in and show them the research rather than me just trying to tell people, or pointing papers at them, so the way it's been broken down has made it a lot easier to introduce it to other members of staff.* - Group Interview 1, Evidence in Action

Where team or department leaders used research strategically, this generally involved them engaging colleagues in collaborative activity that included discussing research and research-informed resources; translating research into lesson or curriculum plans; adapting research-informed resources; and planning for implementation. There were a very few instances of changes being implemented by directly by team or departmental leaders, who subsequently used research strategically to justify the changes, as exemplified by one Head of Department:

> *What I've done... is… completely scrapped [some of the teachers' practicals]… Because there was no benefit other than being a practical and… occupying pupils for an hour… no learning benefit... Some staff were a bit unhappy… But just trying to get through to them that, you know there is a purpose to practical work and if that purpose isn't to progress the pupil, then why are we doing it?* - Group Interview 8, Journal Clubs

The research and resources drawn from the projects were also used strategically to validate the existing research-informed practices; for example, one interviewee whose school had a strong focus on research already, when asked about in-school research use of the resources provided by their project, responded:

> *I was already using it quite a lot to start with, [so], some of that… is validation, we'd introduced Best Evidence Science Teaching questions, so it was quite nice to see all that… research again and to be certain, this is the right way forwards for us* – Teacher 9, Evidence in Action

3.5 Doing research

Headline findings

- All of the interviewees chose a focus for their trial that addressed an individual, team/department, or school practice 'problem'.
- Designing the trial was an iterative process, involving: engagement with pedagogical research; designing the intervention; considering a suitable outcome measure; developing a trial methodology; discussion with the project team and school colleagues; and engagement with the project resources.
- Design decisions and their associated challenges were influenced by: the nature of the proposed intervention; interviewees' prior knowledge of trial design; school size and approach to setting and streaming; and the 'fit' with school priorities.
- Due to COVID-19 related issues, few interviewees had begun to implement their trial, although most intended to do so in the future.

This section illuminates how the participants in the Teacher-led RCT project designed and implemented a small-scale RCT carried during the project lifespan. See Table 5 and Section 2.1 for details of the project teams' brokerage activity.

Trial design

Interviewees reported that the first stage in the process of designing a small-scale RCT was finding a pedagogical focus. In all instances, the chosen focus was rooted in a perceived practice 'problem' – related to their own, their team/department, or their school's practices. In some cases, but not all, these were aligned with the pedagogical areas suggested for trials by the project team. Two of the ten participants interviewed at the end of the project suggested that more support in identifying a focus would have been helpful, as they had found it difficult to find a focus that was aligned with their school's needs:

> *I didn't know what I wanted to research, that was one the stumbling blocks… I felt at… a disadvantage during some of the meetings... because everybody else seemed to know exactly what they wanted to do… I wanted a bit more support with that. …I wanted… something that fitted in with both the school and the department… development plan… because there's no point doing... research that's not going to… help us.* - Teacher 1, Teacher-led RCTs

Designing the intervention to be trialled and the trial methodology was described by interviewees as an iterative process, comprising interaction between:

- engagement with pedagogical research and/or other information related to the intervention
- developing or identifying an existing, valid, easy-to-use outcome measure that was relevant to the area of interest
- devising the trial design, particularly how to set up a control group/s
- discussions with the project team and engagement with the book provided by the project (Churches & Dommett, 2016)[19] and other support resources
- engaging with feedback on their research protocol
- discussions with the school leaders and other colleagues about 'fit' of the proposed trial to school priorities and context.

How the interviewees integrated the different forms of project support into designing their trial is illustrated below:

> *It was sort of… a bit of everything, a bit of reading the textbook, finding out the best way of doing it and then just getting a bit of confirmation* [from the project team from discussing ideas and then feedback on the protocol]. - Teacher 4, Teacher-led RCTs

Overall, the interviewees reported that they felt well-supported when addressing the challenges of trial design. In one instance, feedback on a draft protocol had negatively impacted on an interviewee's self-confidence:

[19] Teacher-Led Research: Designing and implementing randomised controlled trials and other forms of experimental research (Churches & Dommett, 2016).

> *I had a real crisis of confidence because what I thought I was doing right in terms of using two classes and how to set it up, I thought that was going to be right and then they got back in contact with me and said that's not going to work because it doesn't give valid results… but I'm sure that, when I looked at the other posters, somebody had done something similar.*
> - Fully anonymised for confidentiality, Teacher-led RCTs

It is important to note that this interviewee was not criticising the content or manner in which the feedback and, at the time of the interview, was re-thinking their design. Rather, the feedback on the protocol had amplified their existing perception that they had limited knowledge of research design.

As reported in Section 3.1, there was variation in the extent and depth of interviewees engagement with pedagogical research to inform their intervention design. Similarly, there was variation in whether or not the interviewees sought support from the project team on how to translate the research into an intervention suitable for an RCT.

A range of factors were reported to impact on the ease of selecting an outcome measure and designing a trial. A few interviewees reported that identifying or developing an outcome measure was difficult due the nature of their planned intervention, and drew on discussions with the project team to address this, as exemplified below:

> *the only issue I had... was that... I wasn't producing quantifiable data in that it was quality of work... I did spend some time in one of the sessions discussing with the [project team] how I could create some sort of... numerical matrix that I could then [use to] compare work.*
> - Teacher 4, Teacher-led RCTs

School size, particularly in the primary phase, and the arrangements for setting or streaming in secondary schools, were perceived by some interviewees to impact on the ease of constructing intervention and control groups that could be used to make valid comparisons. For example, a teacher in a single-entry primary school reflected on the challenges they faced due to not being able to use parallel classes for the intervention and control groups and how this issue might be overcome:

> *I thought to myself, I can see this just never happening, but actually I can make it happen. What I have to do is book... my TA on… two full mornings rather than just half a morning or one session in the morning… in a smaller primary school... you have to rely on someone else being able to fit it in* - Teacher 9, Teacher-led RCTs, Longitudinal interview

More broadly, a 'fit' with the school context and development plans were a key influence on trial design. Just as the project team acted as brokers in supporting the project participants to carry out research, so the participants themselves brokered conducting research in their school by acting as an intermediary between their school colleagues and the project, as illustrated below:

> *I had discussions with… my head of school and my line manager… to... think about areas to focus on, discussed this with the rest of the team to see if they thought it'd work and how we could make it fit into our current structure so it wasn't disruptive and was something that, if it did work, we could roll out.* - Teacher 2, Teacher-led RCTs

Trial implementation and analysis

Challenges and delays to implementing their trials were reported by all of the interviewees, which they attributed to a range of issues emanating from the COVID-19 pandemic (see Section 6.3). At the time of the endpoint interviews, two interviewees were in the process of implementing their trials and six reported that they were committed to finalising their design and implementing their trial once this became feasible. There are, therefore, limited data on how the participants analysed their trial data. The only interviewee who used the StatsWizard, the online tool provided by the project, reported that they were '*finding some of the statistics a little bit difficult*' (Teacher 6), but were drawing both on the detailed feedback from the project team and a personal contact to help them undertake the analysis.

Summary of findings

Accessing and engaging with research and participant-led translation

Few participants accessed research sources beyond those provided by their project. Their depth of engagement appeared to be determined by the nature of the research provided by their project. Engaging with and translating research to inform practice were highly inter-related processes. Structured discussion and questioning by the project facilitators, the use of critical appraisal and critical implementation tools, and the sharing of professional experience with research-interested colleagues appeared to support participants' engagement with, and translation of, the research.

Project-led translation

Bringing researchers and expert teacher together to co-create research-informed resources for use by project participants was challenging at times. It appeared to be most effective when:

- equal weight was given to both researcher and teacher knowledge
- there were regular opportunities for communication and collaboration between the researchers and teachers - to share knowledge about the research and understand the school context

- topic, subject-specific, science and generic pedagogical research were brought together.

Selection and adaptation of research-informed resources

Where projects provided research-informed resources, participants selected those where there was a fit between the topic and the scheduling of their curriculum. Participants were expected to, and did, adapt the resources, making changes to lesson sequencing, structure, assessment, science vocabulary and the design and content of the associated teaching and learning resources. The reasons for adaptation included teacher judgment and preferences, and a match with the pupils' needs and school requirements. Implementation was faster when the resources were easy to use. The question of whether the adaptations might compromise the fidelity to the research, and so lead to less effective practices, did not appear to have been considered.

In-school research use

Those participants who had implemented research ideas or research-informed practices in their school did this through a 'plan, do, review' cycle. They reported that this was aided through discussions with project and school colleagues, as well as gap tasks, implementation tools, and mentoring. Research use was predominantly instrumental and conceptual, with a few instances of strategic use.

Doing research

A perceived practice 'problem' determined the focus of interviewees' trials. Trial design was an iterative process, involving engagement with pedagogical research; designing the intervention; considering a suitable outcome measure; developing a trial methodology; discussion with the project team and school colleagues; and engagement with the project resources. Design decisions and their associated challenges were influenced by: the nature of the proposed intervention; interviewees' prior knowledge of trial design; school size and approach to setting and streaming; and the 'fit' with school priorities.

Chapter 4: Participants' perceptions of the projects

Chapter 4 presents quantitative and qualitative findings on participants' perceptions of:

- the overall usefulness of their project
- the quality and usefulness of the training, resources, and support provided by the projects.

4.1 Context of quantitative findings

In the endpoint survey, participants were asked about their perceptions of the usefulness of the project they had taken part in overall and also in relation to specific elements of the project. End of project survey questions related to the overall usefulness of the project, as well as training, resources, and support, which were tailored for each project. All participants were asked to rate the usefulness of their project overall as well as each project element on a five-point scale, where 1 was '*not at all useful*' and 5 was '*extremely useful*'. They were also able to select '*I have not accessed this*'. Participants in the Journal Clubs, Evidence in Action and Research-2-Practice projects were asked about these elements in relation to how they supported their science teaching. Participants in the Teacher-led RCTs were asked how useful they had found these elements in helping them to carry out classroom research. Where multiple resources or forms of support were offered, a mean usefulness rating was calculated for each participant. Full tables are provided in Appendices 6.3 and 6.4.

Caution should be exercised when interpreting these findings, as the response rate for these questions was relatively low – approximately half of retained programme participants did not answer these questions. Furthermore, there is an imbalance in the number of respondents by project, which means the programme-level findings are more reflective of some projects than others; for example, there was a substantial variation in response rates when participants were asked to rate the usefulness of the training, ranging from 62% to just 18%. The full response rates are detailed in Appendices 6.2 to 6.5.

4.2 Overall usefulness of the project

Headline findings

- The mean respondent rating for overall usefulness of the project they participated in had been for their science teaching on a 5-point scale was 3.3 – between '*mixed views*' and '*very useful*'.
- The mean rating for the overall usefulness of the Teacher-led RCTs project in helping respondents to carry out classroom research was 4.6 – between '*very useful*' and '*extremely useful*'.

Of the 200 respondents who answered the endpoint survey, asking them to rate '*overall how useful the project they participated in had been for their science teaching*', over half (approximately 55%) rated their project as very or extremely useful. As shown in Table 53, only about 5% of respondents stated that their project was 'not very useful' or 'not at all useful'. The mean usefulness rating was 3.3 (between 'mixed views' and 'very useful').

Teacher-led RCTs participants were also asked to rate the overall usefulness of their project in helping them to carry out classroom research. The majority of the respondents perceived the project as very or extremely useful. The mean rating was 4.6.

Given the impact of COVID-19 and the associated disruption to most of the projects' recruitment and delivery plans, these findings are relatively positive and suggest that the projects made a positive contribution to supporting participants' science teaching. As discussed above, however, owing to the low response rates to these questions, caution is needed when interpreting this. This applies throughout this chapter in relation to the perceived usefulness of training, resources, and support. Caution is particularly necessary when interpreting findings about the Teacher-led RCTs project due to the project having such small participant numbers from the outset and this project being asked a different question to the other three projects.

4.3 Training

The levels, types and intention of training offered to participants varied by project (see Section 2.1 and Appendix 6.4). The mean rating for the usefulness of training in supporting their science teaching across the Evidence in Action, Journal Clubs and Research-2-Practice projects was 3.7 (which is slightly less positive than '*very useful*'), indicating that overall, the respondents who had chosen to access the training (n=153) were somewhat positive about its usefulness. At project level, the mean usefulness rating for training ranged from 3.4 to 3.8.

Nearly two-thirds of respondents (61%) across the Evidence in Action, Journal Clubs and Research-2-Practice projects rated the training as '*very*' or '*entirely useful*'. In contrast, just under 5% reported that the training was '*not at all*' or not '*very useful'*. However, more than half of retained participants from these projects (including those who did not answer the end point survey at all - 53%) did not answer this question. A further 19 (5%) of participants responded to the question to indicate that they had not engaged in the training for their project.

Almost all Teacher-led RCTs participants who responded to the survey rated the usefulness of their training in supporting classroom research as '*very*' or '*entirely*' useful in helping them to undertake research and the mean rating was 4.2, which is slightly more positive than '*very useful*'. However, like the other projects, less than half of Teacher-led RCT participants who were still involved in the project at the time of the endpoint survey (42% or 11 participants) responded to this question, so caution is needed in interpreting this finding.

Overall, the qualitative evidence supports the survey findings that training was mostly positively received. Box 5 below summarises the training-related factors that were found to support research use and associated practice change most effectively.

Box 5: Learning about effective training by projects

Training was perceived to be effective when:

- training was easily accessible, e.g. sessions were recorded and could be revisited or missed session viewed at a later date, or run several times
- there were regular training sessions or meetings over the duration of the project
- training sessions included discussion of project materials and was timed to fit with opportunities for implementation of project learning and resources in school
- there was ongoing discussion with project leaders at training sessions/meetings

Perceived issues with training sessions centred around having time available to prepare for sessions, concerns around small group sizes not being conducive for discussion, and primary teachers feeling that mixed-phase sessions were less relevant to them.

The accessibility of the training was important; for example, the Journal Clubs project provided self-guided online training for facilitators and teachers attending the Journal Clubs, which was viewed positively.

Participants also valued flexibility in accessing sessions; for example, the Evidence in Action project ran multiple versions of each of their four training sessions, as well as recording them, giving participants several chances to attend. The ability to access online videos of sessions to watch if they had missed a session or to re-watch training sessions was also valued. Similarly, the Research-2-Practice mentors were positive about the flexibility of their training. Some interviewees noted that, viewing the training online allowed them to catch-up on the missed session and/or for those had attended they mentioned being able to reflect attend re-watch parts. The online nature of project sessions, which was not necessarily part of the original project plans, was reported by most participants to made engagement with projects easier and less time consuming than a face-to-face approach.

Regular, ongoing training sessions which were clearly linked to available project resources, such as those provided by the Evidence in Action and Journal Clubs projects, were well-received, becoming embedded in teachers' lives, with one participant noting '*It kind of just became part of the normal way of life*' (Teacher 7, Journal Clubs). As a result of the partial school closures the Evidence in Action project ran some sessions before the in-school implementation of the resources was possible, and one interviewee noted that, once the resources were used in school in the summer, the relevance of the training context was much clearer, indicating that that aligning training with opportunity to implement learning in school was important.

Discussions with project teams during training sessions, or meetings, were viewed positively, allowing participants to speak to project leaders, access their expertise and discuss project materials and resources; for example, the two initial sessions helped participants in the Teacher-led RCTs project in terms of setting expectations and introducing the project, as well as being able to discuss their design ideas, with the project leaders who are experts in this area:

> *The bit that was really, really helpful was when we had the webinars right at the start, sort of December time, and we could actually talk to people who are involved in running trials in schools, and we could run our ideas past them and help formulate what we wanted to do, that was so helpful.* – Teacher 6, Teacher-led RCTs

Interviewees also noted the importance of discussion of material and resources and s and feedback, giving a deeper understanding of the resources and the thinking behind them.

Several interviewees noted that the regular sessions were very well managed and facilitated, noting for example:

> *They very much facilitated us talking about ideas and sharing ideas, which I thought was really good, rather than you just feeling as though you were there just listening to someone tell you something.* - Teacher 5, Journal Clubs

> *I thought that the BI Team were excellent. I thought they were really, as a support they were really, really good.* - Teacher 3, Evidence in Action

Several participants also noted that group size was important, and that it can be difficult to maintain and facilitate a meaningful discussion, whether in a breakout session or in a whole group situation, when there are very few participants.

It was noted by some participants that engaging with all the online training and associated materials was difficult, at times. For example, it the amount of training activity provided by the Journal Clubs project was perceived by some interviewees as difficult to complete. Some primary teachers felt that mixed phase groups were less relevant to them, as primary and secondary teaching involves a '*very different way of teaching quite often*' (Group interview 7, Journal Clubs).

4.4 Resources

Headline findings

- The mean combined rating for the Evidence in Action, Journal Clubs and Research-2-Practice respondents for the usefulness of their project's resources for their science teaching was 3.7 – slightly less positive than '*very useful'*.
- The mean rating for usefulness of the Teacher-led RCT resources in supporting respondents to carry out research was 3.9 – slightly less positive than 'very useful'.

The resources provided by the projects varied (see Section 2.1 and Appendix 6.4). The mean rating for perceived usefulness of the resources by Evidence in Action, Journal Clubs and Research-2-Practice respondents who had used their project's resources (n=174) was 3.7 (between '*mixed views'* and '*very useful*'), indicating that, overall, the participants were somewhat positive about their usefulness. At a project level, the mean usefulness rating ranged from 3.6 to 4.1. Over half (52%) of responding participants[20] who accessed project resources rated the average usefulness of the resources that they received as '*very useful*' to '*entirely useful*'. In contrast, 3% rated them as '*not at all useful'* to '*not very useful*'.

Teacher-led RCTs participants' perceptions of the usefulness of the resources in helping them to carry out research were positive, with a mean rating of 3.9 (just under '*very useful*'). However, fewer than half of Teacher-led RCT retained participants (42% or 11 participants) responded to this question, so caution is needed when interpreting this finding.

The qualitative data largely support the survey findings , however, perceptions varied across and within projects. As shown in Box 6, several themes were identified in the qualitative data relating to what participants perceived to be effective resources.

[20] Fifty-two percent of participants who had been retained on the projects did not answer question or indicated that they had not accessed any project resources.

Box 6: Learning about effective project resources

Resources were perceived as being effective when they were:

- available to teachers in good time to enable reading, reflection and planning for use both in project sessions and school
- linked to ongoing training sessions and project meetings
- accessible, easy to understand, adapt (if appropriate) and use -this was particularly relevant to trainee teachers
- not too time consuming to complete, adapt/extend or engage with
- relevant to school phase and context
- structured to scaffold key steps in engaging with or carrying out research

and their purpose in relation to the aims and objectives of the project was clearly defined.

Perceptions of whether resources are effective were influenced by several factors, including teacher experience, expectations, skills, confidence and the level of support available.

The availability of project materials when projects started was seen as important by teachers, as this allowed them to plan when they could use the resources and for research-informed resources how they might fit into their overall scheme of work. As noted in the previous section, materials and resources being linked to ongoing sessions were viewed very positively by participants.

As reported in Chapter 3, research summaries, such as those produced by the Research-2-Practice and used occasionally in the Journal Clubs project, were found by participants to be easier to access than full papers, which were sometimes considered off-putting. One Journal Clubs teacher commented that being given a summary meant that they were still able to engage with the project when their workload was high. Clear links to research sources on research-informed resources were viewed positively. For example, the links to the three research sources within the lesson plans provided by the Evidence in Action project were seen as very useful and a positive aspect of the project. The fact that these were freely-available sources (i.e., not behind a paywall) was also seen as very important.

Ease of engagement with materials was raised as an issue; for example, a small number of Journal Clubs participants found the time needed to complete the CAT CIT burdensome. Lesson plans which included associated resources which could be easily adapted were well received. Having to create supporting resources such as slide packs, notes, practical work instructions, extension work and worksheets etc. was seen as a barrier to use. Opinions amongst Evidence in Action interviewees varied around extent of adaptation that was required for use in school.

There were also differences of opinions as to the teaching approaches advocated in lesson plans and the skills required to use these; for example, some interviewees were positive about the active learning approaches advocated in the Research-2-Practice lesson plans, with a narrative approach to teaching adaptation and evolution being noted as useful. However, one mentor noted that they did not think they had the skills to teach electrolysis using drama. Similarly, although opinions on the accessibility and usefulness of the Evidence in Action lesson plans were generally positive, some teachers stated that they were too detailed, while others thought that they were not detailed enough. One interviewee noted that a colleague who teaches Biology found the lesson plan *'overwhelming… just cognitive overload'* (Teacher 5, Evidence in Action), possibly indicating that the plans were best suited to physics specialists. Another teacher stated '*They are definitely accessible. If anything, I wouldn't say they were thorough enough'* (Teacher 3, Evidence in Action).

Relevance of materials to context was seen as key for some primary teachers; for example, several of the Journal Clubs participants thought that some articles were not useful to them. One primary teacher noted, '*One of the first journal articles… lumped primary schools all together*' (Teacher 4, Journal Clubs). However, the choice of journal articles by the Journal Clubs project team intended to provide exposure to a broad range of research methodologies, methods, and topic areas. It was inevitable, therefore, that participants would not find specific relevance in every article. This could perhaps have been made clearer by the project team.

Participants valued materials that gave them a structured approach to engaging in or carrying out research; for example, the tools supplied by the Journal Clubs project and the resources (including videos, webinar recordings, and templates) provided by the Teacher-led RCTs project team. The book (Churches & Dommett, 2016), supplied as part of the Teacher-led RCT resource package, was mentioned positively as being helpful in providing structured guidance on designing and setting up RCTs, and in helping to support the discussion with project staff during webinars. One teacher noted:

> *I read everything in the book up to the point where I'm at with my trial and I found that very helpful in terms of designing my trial.* - Teacher 2, Teacher-led RCTs

As illustrated above, there were varying opinions on the project materials, lesson plans and supporting resources provided by projects, however, given the breadth of the potential audience it was unlikely that all project resources would be received positively by all participants. This was noted by one interviewee who stated, '*I think you're never going to write a lesson plan as part of the project that's going to appeal to everyone'* (Trainee teacher 8, Research-2-Practice). For example, some trainee teachers participating in the Research-2-Practice project noted that they had not found the lesson plans as accessible as hoped, however the mentors were much more positive. These differences in perceptions may have been because of differing levels of teaching experience; had the project run as intended, trainee teachers would have had the support of their mentors in using the plans and may have found them more accessible and useful. Equally they could be differing expectations of what a lesson plan might look like and contain, with trainee teachers being less able or less confident in engaging with the research summaries and adapting the lesson plans for practice. The following quotes illustrate the conflicting opinions of mentors and mentees:

> *The resources themselves were fantastic.* - Mentor 11, Longitudinal, Research-2-Practice

> *They were really difficult to work through... they were unbelievably dense and you weren't quite sure what the lesson plan or the outcomes were... it seemed to be very focused on here's all the research that we've used to back this up… There wasn't anything that... said, right here's an idea, do this.* - Trainee teacher 2, Research-2-Practice

4.5 Support

Headline findings

- The mean combined rating for usefulness of the Evidence in Action, Journal Clubs and Research-2-Practice projects' research support was 3.8 (only slightly less positive than '*very useful*'); however, 62% of participants retained on the projects did not answer this question or did not access the support offered by their project.
- The mean rating for the usefulness of the Teacher-led RCT project support for carrying out research was 4.0 - '*very useful*'.

The support provided to participants varied across the projects (see Section 2.1 and Appendix 6.4). In interpreting these data on support, it is important to note that Journal Clubs were categorised in the survey as support, rather than training.[21]

At combined the Evidence in Action, Journal Clubs and Research-to-Practice project level, the mean survey rating of the usefulness of their support for science practice was 3.8 (only slightly less positive than '*very useful*'). However, only 139 (38%) of participants retained on the programme answered this question and provided a usefulness rating. There is also an imbalance in the number of responses representing each project, with two-thirds of responses to this question coming from Journal Clubs participants.[22] The remaining 62% of the participants either did not answer the survey or indicated they had not accessed any support provided by their

[21] The Journal Clubs self-accessed online training modules were categorised as 'training'.

[22] Eighty nine responses came from the Journal Clubs participants compared to 37 from Evidence in Action and 13 from Research-2-Practice.

project. The mean rating for the three projects (Journal Clubs, Evidence in Action and Research-2-Practice) ranged from 3.2 to 4.0.

Overall, the 'support' elements of these projects appear to have been regarded as of similar usefulness in supporting classroom science teaching as the provision of training and resources. Approximately 11% of respondents did not access any support and about 27% rated the support received, on average, as '*not very useful*' or '*not at all useful'*. Almost 62% of respondents rated the support as between '*very useful'* and '*extremely useful'*, on average.

Teacher-Led RCTs respondents' perceptions of the usefulness of the support for carrying out research were mixed, with a mean rating at 4.0 or '*very useful'*; however, as previously discussed, fewer than half of the Teacher-Led RCT participants (42% or 11 participants) responded to this question and so caution is needed when interpreting this finding.

In line with the survey findings, the qualitative data showed that there were mixed perceptions about the usefulness of project support. Box 7 lists the points identified from the qualitative data concerning effective support.

Box 7: Learning about effective support

Effective support was perceived as including:

- support provided by project teams or facilitators at ongoing sessions
- opportunities for discussion with peers
- prompt responses to queries and concerns from project teams

Interviewees perceived that they received useful support through engagement with project teams, facilitators and peers at regular training sessions or meetings. Being able to share ideas with other participants and learn from those already using project resources during breakout sessions was valued. Sharing ideas and talking openly about research evidence with other like-minded teachers was a strong theme among Journal Clubs participants. Similarly, while training was also the primary purpose of the Evidence in Action sessions, interviewees also regarded sessions as a form of project support, noting that they allowed discussion of wider issues and enabled them to connect with peers outside their own school. Journal Club participants, in particular, valued the general support of peers during the periods of partial school closures when their interactions with school colleagues was more limited.

For some participants in the Research-2-Practice project, where trainee teachers were to be supported by ITE mentors, there appeared for some to be an issue as to who was to 'bring up' and 'push on' progressing their engagement with the project. This lack of clarity around expectation and roles meant that in some cases neither the mentors, nor trainee teachers, took responsibility for moving project work forward.

Overall, it seems that the ongoing training or meeting provided by some projects supported continued project engagement:

> [Journal Clubs] *kept me sort of in the programme and keep going with things, because it did feel supportive.* - Teacher 6, Journal Clubs

> *I thought that the BI Team were excellent… as a support they were really, really good.*
> - Teacher 3, Evidence in Action

Queries and concerns being addressed swiftly by the project teams was viewed positively. The use of online messaging for support was noted by the Teacher-led RCTs participants:

> *Whenever I've had a question or I'm not quite sure how to do this side of it, and I've sent an email… I got a really, really long email back that addressed everything that I'd said, which was brilliant and incredibly helpful.* - Teacher 6, Teacher-led RCTs

Summary of findings

Overall usefulness of the projects

Overall, the programme was perceived as somewhat useful in supporting classroom teaching and carrying out classroom research. Participants who accessed the training, resources, and/or support appear to have found them of similar usefulness, though there is some variation by project. In the case of these questions, however, fewer than half of participants responded, particularly in relation to the usefulness of the support they had received, and so caution is needed when interpreting these findings.

Effective training

Training was perceived as effective and timely when it was regular and ongoing, particularly when linked to resources/materials; this appeared to boost project engagement. Availability of supporting resources, ability to watch pre-content, and opportunity to speak to project staff were viewed positively. Sessions being run more than once and being able catch up on missed sessions via recordings were valued as approaches.

However, the time needed to attend and/or prepare for training sessions was felt to be an issue by some interviewees, however. Some participants thought that smaller group sizes could make discussions more difficult and the mixed phase sessions were viewed as less useful by some primary teachers.

Effective project resources

An awareness of the resource content in advance gave teachers the ability to plan. Participants valued resources that were accessible, clear, and easy to use/adapt/extend/reflect on. This was particularly relevant to trainee teachers. Resources which provided a structured approach to assessing research evidence/implementing research/carrying out research were considered important and helpful.

As noted above, the fact that the resources were linked to ongoing sessions was seen as very helpful and gave the participants an opportunity to discuss the resources and practice with the project team. Clear relevance to school phase was important and clear links to evidence were viewed positively.

Effective support

Swift responses to concerns and queries were valued, along with ongoing sessions and communication, and peer support.

Chapter 5: End of programme outcomes

Chapter 5 draws on quantitative and qualitative data in order to report:

- findings from a quantitative change-over-time analysis of a baseline survey, repeated at the endpoint of participants' research use and science pedagogy
- findings from a qualitative thematic analysis which explores:
    - participants' perceptions of the outcomes for themselves, their school and their wider networks
    - explanations for the observed survey outcomes
- qualitative vignettes, illustrating how participation in their project led to the end of programme outcomes
- project teams' future plans.

5.1 Considerations when interpreting the outcome findings

The approach to the survey and qualitative analyses are summarised in Chapter 1 and full details can be found in Appendix 3.

The survey outcome data are reported at the programme,[23] rather than project, level, because the study was not designed to test the 'relative effectiveness' of different project approaches but, rather, to consider the contribution of the projects, in combination, to the achievement of a range of participant outcomes. From a practical perspective, the number of participants answering the survey at both baseline and endpoint within each project, was also generally too small to support either a project-level analysis or project-level subgroup analysis within the programme dataset. One small exception was that we asked the Teacher-led RCTs participants a small number of additional survey questions related to their confidence in designing, implementing, analysing, and supporting others to undertake small-scale RCTs, because this was a unique feature of their project. The responses to these questions were analysed separately. These participants were also invited to complete all of the core survey questions, along with the participants from the other three projects.

Survey

In interpreting the survey findings, it is important to note the following four methodological issues. The net result of these is that we suspect that the survey analysis presents a slightly inflated picture of positive change, although the findings are definitely encouraging.

[23] By this, we mean the combined outcomes across the four projects, with all project data combined into a single 'programme' dataset.

Small sample size:

As a result of the considerable attrition between baseline and endpoint (probably related to the challenges facing teachers during the COVID-19 pandemic), our matched sample (participants who answered both the baseline and endpoint survey) contained only 198 responses. For a small number of participants it was not possible to generate the factors, as they did not respond to all of the survey items. As a result, the change-over-time analysis of the research use factors was based on 191 respondents, while the analysis of the science pedagogy factors was based on 188 respondents. Although the matched sample was smaller than hoped, it was still sufficiently large to support our analysis.

Imbalance between the number of respondents by project:

The matched sample had an imbalanced number of respondents from each of the four projects, with the Journal Clubs respondents constituting almost half of the matched sample. Because of this, we completed an additional sensitivity analysis, in which the change-over-time analysis was conducted on the sample, with the responses from the Journal Clubs participants excluded. This analysis revealed the same pattern of significant changes over time when the Journal Clubs participants were excluded as when these participants were included in the sample and so is not included in this report. This enhances our confidence that the changes observed in the analysis were not driven solely by the largest project.

Non-measurement of the counterfactual:

All of survey findings reported in this chapter should be interpreted with a degree of caution, because our survey design did not include a comparison group.[24] As a result, we can only demonstrate an association between the programme and the outcomes observed, rather than a causal link. It is possible that the outcomes reported throughout this chapter might have occurred even in the absence of the programme or been driven by something other than the programme.

Self-report data:

As usual with survey data, the outcomes reported in this chapter are based on the participants' self-reports of their attitudes, behaviour and practices, rather than an objective measure - such as observation of their practice. While this can create bias in a single time point survey, our analysis took this into account by asking the participants identical questions at baseline and endpoint. This enabled us to measure the extent of any 'change' in their reported attitudes,

[24] The Wellcome Trust were not able to fund an additional survey of non-participating teachers, which would have enabled us to measure the counterfactual.

behaviour, and practices over time.

Qualitative analysis

It is acknowledged that, in relation to the school and wider outcomes, the data presented are the participants' perceptions and have not been collected through any measure of change. We do not, therefore, attribute the reported outcomes to the programme or individual projects. Where the interviewees linked a self-reported outcome or outcome observed in the survey analysis with their project, we present this as a perceived association.

It is important to note that the majority of the participants were committed to research use when they joined the programme. Had this not been the case, their perceptions may have differed.

5.2 Research use outcomes

Introduction

This section presents and explores the changes in the participants' use of research, as achieved by the end of the programme. The outcomes are reported in relation to the following research use constructs:

- Accessing and engaging with research
- Translating and applying research and research-informed resources
- Using research in one's own teaching
- Carrying out research (the Teacher-led RCTs project only).

The findings draw on both survey[25] and qualitative data. They provide an empirical assessment of the programme's contribution to the changes in participants' use of research, supported by rich qualitative insights exploring the patterns observed. The survey questions were asked both before and after programme activity, to measure any changes to which the programme might have contributed. We conducted a factor analysis on these questions at baseline to derive the research use measures (see Appendix 5 for details). This process identified four factors (measures), all with good reliability. See Appendix 6 for a descriptive analysis of the factors at baseline and endpoint. These were labelled by the research team as follows:

[25] The survey contained three sets of questions about the participants': 1) research use; 2) science pedagogical practices; and 3) satisfaction with their respective projects. Survey questions supporting Section 5.1 of this report (part 1) were developed from NFER's Research use Survey (Nelson et al., 2017 – see Appendix 3 for details).

The teacher:

- is confident in accessing research evidence (reported in 'Accessing and engaging with research')
- is confident in assessing the quality of research evidence (reported in 'Accessing and engaging with research')
- is confident using and applying research evidence (reported in 'Translating and applying research and research-informed resources')
- actively uses research evidence in practice (reported in 'Using research in own teaching').

The survey also posed some additional bespoke questions for the participants involved in the Teacher-led RCTs project about their confidence to carry out their own research. The frequency results are presented in the 'Doing research' Section.

Accessing and engaging with research

Headline finding

- There was a statistically significant improvement after involvement in the programme in the participants' confidence to access and assess the quality of research evidence. This confidence was aided by some of the projects providing 'pointers' about where to find relevant research and identifying things to 'look out for' when assessing the quality of research evidence.

The survey showed statistically significant increases over time in the participants' confidence in two key aspects: access and engagement (knowing how to access relevant material,[26] and feeling able to assess its quality[27]) (see Table 6). The effect sizes show that the magnitude of change for both factors was moderate to large.[28] Although we cannot demonstrate causality from these findings, the participants clearly generally felt more confident at the end of the programme than before it started based on these two measures. Additionally, overall, the qualitative data support these positive findings, as illustrated by the following quotes:

[26] Factor 1 comprised two items situated within different survey questions: 'I know where to find research that may help to inform my science teaching' and 'I am confident in locating research information that is relevant to science teaching'.

[27] Factor 2 comprised two items situated within different survey questions: 'I am able to assess the quality of research' and 'I am confident assessing the quality of the research'.

[28] Cohen's d effect sizes can be interpreted as d = 0.0-0.2 (small magnitude); >0.2-0.5 (moderate magnitude); > 0.5 (large magnitude).

Confidence to access research evidence:

> *For us the biggest benefit… was just staff confidence, giving them better teaching methods and reminding everyone including myself… what research is available and how easily accessible it is and actually how relatively easy it is to put into our lessons.* – Teacher Group Interview 1, Evidence in Action

Confidence to assess the quality of research evidence:

> *I think confidence with reading research papers again and evaluating them. I think more confidence with asking questions as well… I now know some of the things I should be looking out for in terms of what makes good research or excellent research compared to poorer research.* - Teacher 6, Journal Clubs

Table 6: Changes in participants' confidence in accessing research and assessing research quality

Factor The teacher…	Baseline Mean	Endpoint Mean	Difference	95% confidence interval of the difference	Significant difference? (p-value)	Effect size (Cohen's d)	95% confidence interval of the effect size
1. is confident in accessing research evidence	0.00	0.33	0.33	0.241-0.426	Yes (<0.001)	0.516	0.365-0.667 -
2. is confident in assessing the quality of research evidence	0.00	0.33	0.33	0.237-0.427	Yes (0.000)	0.500	0.349-0.650

Translating and applying research and research-informed resources

Headline finding

- There was a statistically significant improvement after involvement in the programme in the participants' confidence in using and applying research evidence. This was aided, on occasion, by the participants becoming more familiar with the literature concerning science pedagogy and/or research-informed resources and by their project supporting them to helping them plan for implementation of that learning.

The survey showed a statistically significant increase in the participants' confidence in using and applying research evidence, with a large effect size (d=0.542) (see Table 7). This is positive, especially as the factor on which this finding is based was comprehensive, comprising a number of items across a range of research engagement domains. These included confidence related to:

- discussing research with others (collaboration)
- knowing what the research says about effective science teaching (knowledge)
- using research to inform thinking about science teaching (conceptual change)
- using research to change or develop science teaching (instrumental change)
- using research to persuade others to change or develop their science teaching (strategic change)[29]
- monitoring and reviewing the application of research in science teaching (evaluation).

Table 7: Changes in participants' confidence using and applying research evidence

Factor The teacher…	Baseline Mean	Endpoint Mean	Difference	95% confidence interval of the difference	Significant difference? (p-value)	Effect size (Cohen's d)	95% confidence interval of the effect size
3. is confident using and applying research evidence	-0.02	0.30	0.31	0.231-0.396	Yes (0.000)	0.542	0.390-0.693

[29] The classification of research use as 'conceptual', 'instrumental' or 'strategic' was first developed by Weiss (1979) see Section 1.4.

The qualitative evidence also indicates a growth in confidence in using and applying research evidence, having discussed it with peers or more knowledgeable others, through project involvement or in schools. It seems that 'buying into' research evidence is key, and when this happened, the participants adopted and or adapted suggestions from the research, or adapted research-informed resources, to suit their own context. The following vignette highlights how one teacher, engaged in the Journal Clubs project, interpreted a particular research article to inform their planning and deployment of an approach to support their pupils' use of the internet to find information on a specific topic - in this case, 'Volcanoes':

Vignette 1: Applying research evidence

Participation in the Journal Clubs project gave this teacher the confidence to apply research to change how they asked their students to carry out research. The participant had drawn on Zhou & Lam (2019), a systematic review of scaffolding for online information searches, albeit for older students. The teacher acknowledged that issues often arise when primary students are asked to undertake an online search and described how she had changed her approach:

> *We're doing volcanoes, we've got an IT session, get on a computer and find out about volcanoes… and, of course, they then type in volcano; they have three million hits. They click on the first one, which is Wikipedia, and then they proceed to copy down everything in Wikipedia onto a piece of paper, and that constitutes research. So what I was… saying was… we're going to do some research but I was pre-choosing some useful websites for them, so that I would then give them a bit more direction, which therefore made the data they were getting more useful. Then also giving them a set of questions that I wanted answered related to the subject… the research… suggested that, by preparing the ground for them, giving directions to the website that they should use, you're likely to get better value information. And, also, they are likely to be more interested in it and not feel that it's an exercise in copying something down from a screen. And that worked quite well… what the children have found out… was more useful; it allowed them to move forward with their learning, a lot better… the research, I think, provided just a little bit more confidence in direction, and also… more clarity in the ideas and how to put it into practice in the teaching environment… the research sort of gave you some ideas on where to start.* - Teacher 5, Journal Clubs

This teacher noted that, prior to engaging in the project, they felt reticent about using research evidence due to a concern about a potentially irretrievable negative impact on pupils should the planned approach prove ineffective:

> *If it doesn't work, you're never going to get that time back with the children... if it doesn't work with that class, with that year group, you're never going to get a chance to get that back.* - Teacher 5, Journal Clubs

However, as Vignette 1 demonstrates, the teachers' confidence had increased to the extent that they felt comfortable about applying research evidence and changing their usual practice.

Naturally, there is evidence that not all of the participants were able to deploy learning from their respective project in a classroom environment, as discussed elsewhere in this report.

Using research in one's own teaching

Headline finding

- The survey showed that there was a statistically significant improvement after involvement in the programme in the participants' use of research in practice. This change appears to have been enabled by a combination of participants changing their thinking about teaching and learning and acting on the research-informed learning they had extracted from research or using research-informed resources.

The survey detected a significantly positive change in the participants' use of research evidence in practice. The factors measuring this included the following items:

- research plays an important role in informing my science teaching
- I have adopted new science teaching techniques based on findings from research
- I use research to help me decide how to implement new approaches in the classroom
- I believe that using research will help to improve pupils' science outcomes
- I use research to make changes to my science teaching.

This is particularly positive, as (albeit self-reported) changes in actual practice (as distinct from changes in attitude or confidence) are often difficult to detect. The change in magnitude was smaller than detected on the confidence outcomes, but not insubstantial (d=0.328) (see Table 8).

Table 8: Change in participants' use of research evidence in practice

Factor The teacher…	Baseline Mean	Endpoint Mean	Difference	95% confidence interval of the difference	Significant difference? (p-value)	Effect size (Cohen's d)	95% confidence interval of the effect size
4. actively uses research evidence in practice	0.01	0.19	0.18	0.103-0.262	Yes (0.000)	0.328	0.182-0.473

Many of the interviewed teachers spoke about the positive impact that involvement in their particular project had on their teaching practice, whether that was through engaging with research directly, drawing on research-informed resources, or carrying out research. While the quotation below, from a teacher involved in the Journal Clubs project, is especially positive and describes the impact of engaging with and translating research to inform practice themselves, it is reflective of the generally positive sentiments expressed across the projects:

> *The role of guidance in inquiry-based teaching and learning, the RW Lazonda article, as a result of reading that article I have now got some different ideas as to how I can deliver practical lessons and I genuinely believe that my ability to do that has improved, and my students' outcomes as a result of that have improved.* – Teacher Group Interview 9, Journal Clubs

While the projects primarily focused on supporting instrumental research use, the interviewees also reported changes in their pedagogical thinking or cognitive use of research, as illustrated by the quotation below from a trainee involved in the Research-2-Practice project:

> *We've looked at things together and that's us thinking, my mentor agrees that we use too many worksheets and children work from just looking at pictures, which doesn't help the information to stick in their memory and, if you go back to it and try, the children can't recall a lot of information. Whereas, when we've used hands-on activities, the children learn better and remember better, so she agrees that, next year, we'll change how we teach.* - Teacher Trainee 3, Research-2-Practice

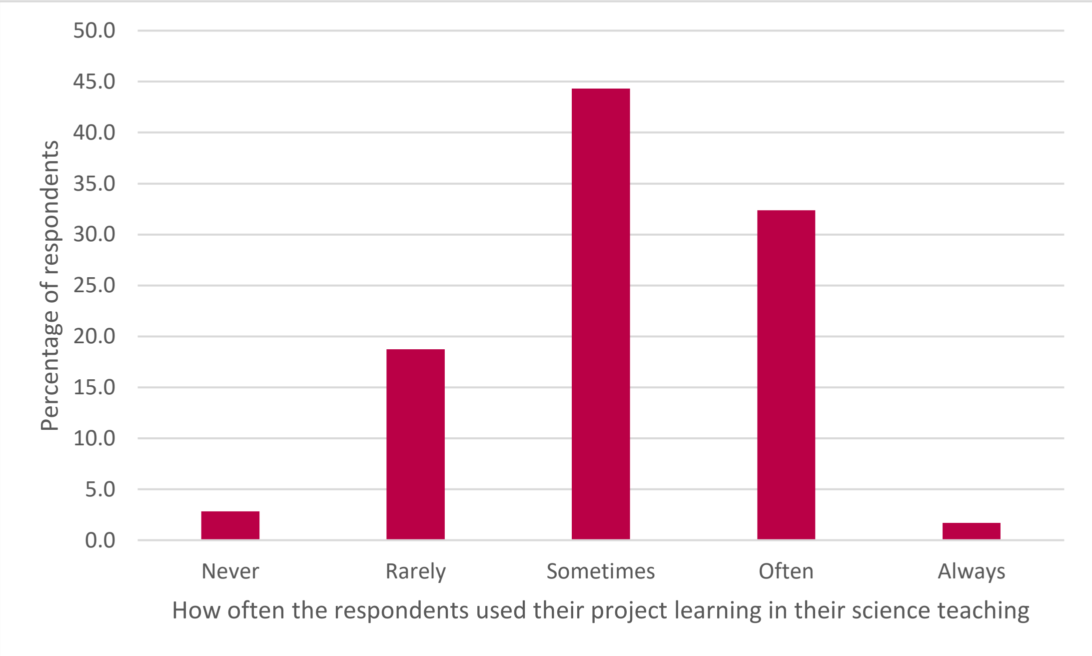
Participants' perceptions of the projects' contribution to supporting research use

Headline finding

- The participants' retrospective self-report of the use of project learning in their science teaching is lower than the change-over-time analysis indicates, and varies greatly by project.

In the endpoint survey, we asked the participants how they had applied their project learning in their teaching practice. These retrospective data are quite different to the change-over-time measurement data reported in Table 8, which recorded how the participants responded to the same questions about their respective use of research before and after their programme involvement, with no direct reference to their projects. Usually, if projects have been popular, retrospective findings can over-estimate their potential impact but, in this instance, the participant reports of their application of project learning were quite mixed. Figure 2 shows that retrospectively, overall, most of the respondents reported applying their project learning to some extent (the mean rating was 3.1, which is slightly more positive than 'sometimes'), with 44% saying that they 'sometimes' used the learning, and a further 32% saying that they 'often' used it. Approximately 22% of the respondents, however, said that they rarely or never used their project learning.

Figure 2: The frequency with which the respondents used their project learning in their science teaching



*N=176

At the project level, the extent to which the respondents applied their project learning varied greatly, ranging from 2.3 (slightly higher than 'rarely') to 3.7 (slightly lower than 'often'). However as discussed, due to the low response rates, caution is needed when interpreting this finding.

The qualitative analyses found significant variation in research use, dependent on the project. The findings presented in Chapters 3 and 4 support the survey findings on variation in research use across the projects. It appeared that easy-to-implement lesson plans and resources led to higher levels of research use during the lifespan of the projects. Also, where resources were not made available until late in the project, the participants were unable to implement them in that year's curriculum.

Doing research

Headline finding

- The survey findings showed increases in participants' confidence in designing and implementing RCTs; and smaller increases in their confidence in analysing data from, and supporting others to undertake, RCTs. Due to the small sample size, we could not test the statistical significance of these findings. The more limited changes for analysis, and supporting others, appears to have been influenced by the COVID-19 pandemic, which limited the opportunities for the participants to implement trials and support others to conduct replications.

The participants involved in this project were asked a small number of bespoke survey questions, which were additional to the survey questions answered by participants across all four projects. These focused on their confidence in: 1) designing; 2) implementing; 3) analysing data from; and 4) supporting others to undertake small-scale RCTs. They were asked to rate their confidence on a five-point scale (1 = 'Not at all confident' to 5 = 'Entirely confident') or could answer: 'I don't do this'.

The survey detected positive changes across all four confidence items when the mean confidence rating at baseline was compared to the mean rating at endpoint. The largest changes were related to designing and implementing (a 1.7-point and 1.6-point increase in the respondents' mean confidence in implementing and designing RCTs, respectively). For both items, the level of confidence increased from approximately 'not very confident' to almost 'very confident' (see Table 9). It is important to note that, owing to the small number of project participants (n=28), it was impossible to conduct a t-test to investigate the statistical significance of these changes, so they should be treated with caution.

Table 9: Research-led RCTs – changes in participants' confidence in carrying out research

Item: The teacher is confident….	Baseline Mean	Endpoint Mean
designing a small-scale RCT	2.14	3.75
implementing a small-scale RCT	2.14	3.83
analysing data from a small-scale RCT	2.11	3.33
supporting others to undertake a small-scale RCT	1.93	2.67

The qualitative data also indicate that the project may have contributed to improving confidence in designing and deploying RCTs in schools. The quotation below provides an illustration:

> *I think I feel more confident in being able to understand what the different trial systems and set-ups actually meant and how that would affect the outcomes… I had planned to have a colleague who works in a different school replicate what I've been doing but, because of COVID, it's just been impossible to organise.* - Teacher 2, Teacher-led RCTs

In the survey data, there were small increases in the participants' confidence in analysing trial data (from around 'not very confident' to just above 'somewhat confident') and supporting others to undertake RCTs (from just below 'not very confident' to nearly 'somewhat confident'). As the Teacher-led RCTs project managers and most of the interviewees participating in the project noted, the COVID-19 pandemic had limited participants' opportunities to implement their trial during the project lifespan, so they neither engaged with the project support for analysis nor supported others to perform replications. This is reflected in the previous quotation, and may explain the weaker observed changes related to analysing data and supporting other to undertake a small-scale RCT.

The qualitative data also suggest that the Teacher-led RCTs participants gained confidence in implementing the findings of their and others' research. The following quotation highlights the common findings of teachers' increased confidence in understanding trial design, and realisation that trials were not difficult to undertake and can help to change practice:

> *We looked at limitations and different designs and the strengths of different designs of trials. So, knowing more about that means I feel more confident when I look at something. I usually just skip past the data section and now I think I feel more confident in being able to understand what the different trial systems and set-ups actually meant and how that would affect the outcomes. I would say that, again, just knowing that it's much easier to do and*

how we can easily change practice based on a little bit of research. - Teacher 2, Teacher-led RCTs

5.3 Science pedagogy outcomes

Introduction

This section presents and explores changes in the participants' science pedagogical practices at the end of the programme. The findings draw on both survey and qualitative data. They provide an empirical assessment of the programme's contribution to change, supported by qualitative insights explaining the patterns observed. The survey items were designed to align with seven recommendations identified in the EEF's *Improving Secondary Science Guidance Report* (Holman and Yeomans, 2018), adapted as necessary for the primary phase.

As in the case of the research use survey items, we conducted factor analysis on the science pedagogy questions at baseline to derive science practice measures (see Appendix 5 for details). This process identified six factors (measures), all with good reliability. See Appendix 6 for a descriptive analysis of the factors at baseline and endpoint. The factors were aligned very closely with the recommendations in the EEF guidance report, confirming that the survey provided a valid measure of the constructs that it set out to assess. These were labelled by the research team as follows:

The teacher:

1. supports pupils to challenge misconceptions and review their learning
2. uses practical work purposefully
3. uses models to support understanding
4. uses practices that support the retention and retrieval of knowledge
5. helps pupils to develop scientific vocabulary
6. supports pupils to direct their own learning.

One set of items (related to using formative feedback approaches - the seventh EEF recommendation) did not load successfully onto any of the factors. We were interested in exploring pedagogic changes in relation to formative feedback; therefore, in the section below, we provide evidence of change over time based on the *individual survey items* related to this outcome. While the individual items provide a less robust basis for measuring change than the composite factors, their analysis nevertheless provides some interesting insights.

Findings

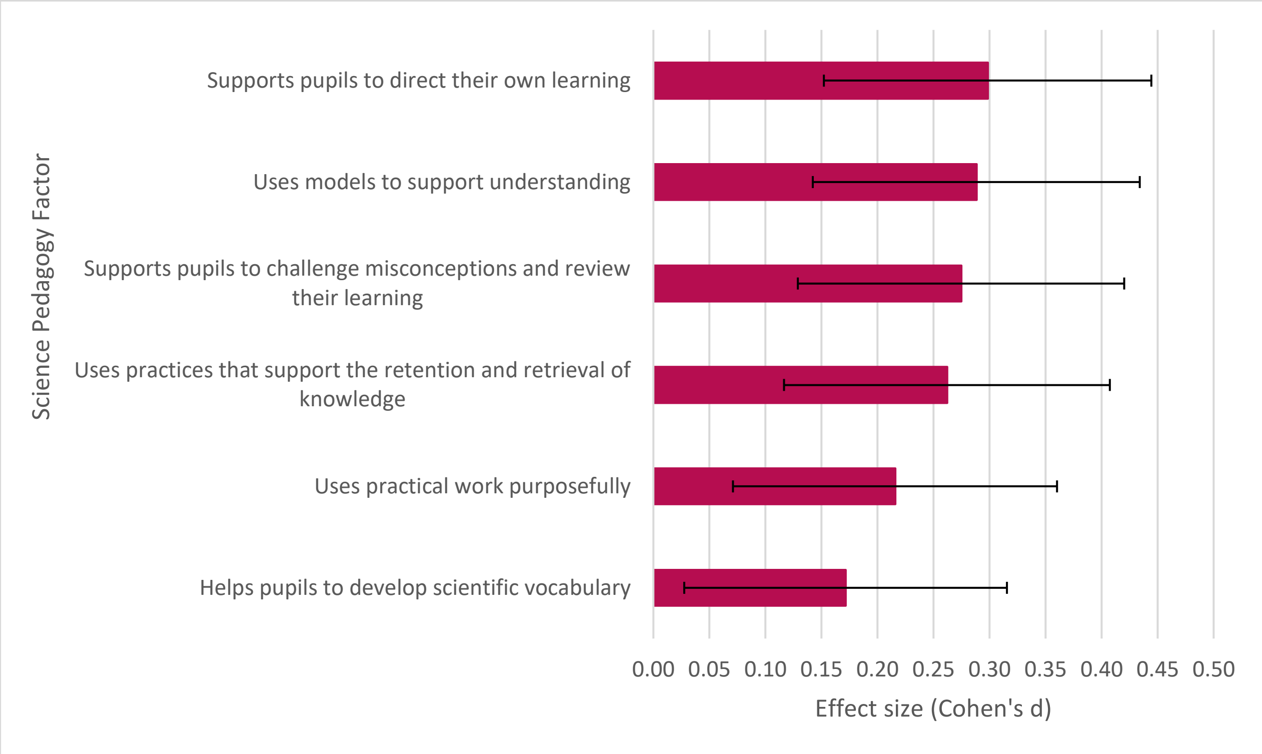
Headline findings

- There was a statistically significant positive relationship between the participants' involvement in the programme and their reported science pedagogical practices. The participants were more likely to use evidence-informed science practices across all of the pedagogic measures explored in the survey (with slightly weaker results for 'using structured feedback') by the end of the programme compared with before it started.
- The qualitative analysis particular evidence of changes in relation to the strategies supporting metacognition, self-directed learning, retrieval practice, and helping pupils to address scientific misconceptions.

The survey detected statistically significant positive changes across all six science pedagogy factors. This is a positive finding, suggesting that the programme may have contributed to research-informed change across a wide spectrum of science pedagogic practices among the individuals who participated in it. These practices ranged from effective uses of scientific practical work and modelling, through approaches to helping pupils to develop their scientific vocabulary, to more generic pedagogies, applied in a science teaching context. These included the application of metacognitive and retrieval practices - helping pupils to manage their own learning.

The following bar chart (Figure 5) shows the effect sizes (Cohen's d) of the observed changes in science pedagogy outcomes between baseline and endpoint. The error bars on either side show the 95% confidence interval for the effect size of each outcome. Cohen's d effect sizes can be interpreted as d = 0.0-0.2 (small magnitude); <0.2-0.5 (moderate magnitude); > 0.5 (large magnitude).

Figure 3: Effect sizes and 95% confidence interval for the science pedagogy outcomes



Although these changes undoubtedly appear to be positive, their magnitude was relatively small (ranging from effect sizes of 0.172 to 0.299 – see Appendix 6) so, while we observed statistically significant positive change across a range of pedagogical practices (with p-vales ranging from 0.000 to 0.020 – see Appendix 6) we cannot claim that the change was extensive, nor state that there was a causal relationship between the programme and the outcomes.

The pedagogical practices with the largest magnitude of positive change (relative to other practices) were related to metacognition and self-directed learning (supporting pupils to direct their own learning (d = 0.299); supporting pupils to challenge misconceptions and review their learning (d = 0.275); and using practices that support the retention and retrieval of knowledge (d = 0.262)). One specifically science-focused pedagogy also saw a slightly larger magnitude of change relative to other pedagogies - using models to support understanding (d = 0.289).

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The qualitative data support many of the quantitative findings reported in this section, particularly regarding metacognition, self-directed learning, pupil misconceptions, and retrieval practice, as explored below. These findings mainly emerged from the Evidence in Action and Journal Clubs projects, reflecting the Journal Clubs project's selection of papers and research underpinning the Evidence in Action lesson plans and resources.

Misconceptions

The theme of pupils' 'misconceptions in science' was seen most frequently in the Evidence in Action participant data. The IOPSpark misconceptions resource was one of the project's three key research sources. One teacher noted that their thinking about, and use of, questions had developed after engaging with this:

> *Having looked at that the…* [IOPSpark] *misconceptions, that then informed the style of question that I was going to use, sort of type question that I'd planned for at certain points in the lesson. Just to try and address those issues and tease out any misconceptions that might be there, so we can address them.* – Teacher 1, Evidence in Action

Retrieval practices

Several of the mentors from the Research-to-Practice project commented on the usefulness of the misconceptions sections of the provided resources, in terms of having discussions with their trainee teachers and increasing their subject knowledge.

The theme of 'retrieval' was mentioned by a number of programme participants as being an important issue within schools, who indicated that project engagement had helped to support their strategy development and practice in this area. One teacher on the Evidence in Action projected noted '*Retrieval practice is something that we've been, like, building up more over the last couple of years, but there was obviously a huge emphasis of it on this project which we really liked*' (Teacher 5, Evidence in Action). The resources provided by the project had caused the same teacher to reflect on how they had previously taught electricity:

> *There was a very, very slower pace and less content* [in the Evidence in Action resources], *and that's something that I'm still reflecting on… I felt students were mastering the concepts a lot more, that they were remembering the key information… I'm looking back on what we'd done before and thinking, like, was there just an overload* - Teacher 5, Evidence in Action

A growing recognition of the importance of some of the concepts outlined in this section to inform practice, is emphasised in the quotation by a Journal Clubs participant:

> *I think that evidence-based practice comes from psychologists, and how teaching and learning works so, from my point of view, some of these, they're not fads, are they? So an*

> *understanding of cognitive theory, retrieval practice, spacing, metacognition, has all come to the forefront of my practice.* - Teacher Group Interview 8, Journal Clubs

Models

While references to the use of models to support teaching and learning do not emerge frequently across the qualitative data set, it is interesting that the participants in Evidence in Action found the lesson plans of particular use in this respect:

> *I think my favourite thing from the project was the rope model and how the rope model kept coming back in different lessons, like with a little bit of added complexity each time so it was… like securing the concept at the start and then adding complexity every time we came back to it, and it's not a model that I'd actually used in teaching before and* [the popular models]*… like the water model… I've always hated them, so this's the first conceptual model that I've actually found is really useful for the students in understanding it.* - Teacher 5, Evidence in Action

Practical work

The survey showed a relatively small, but nevertheless positive, change in the survey factor: 'uses practical work purposefully' (d = 0.216). The interviewed participants also mentioned making changes to their planning and use of practical work. They found that engaging with research had highlighted the importance of identifying the purpose and careful planning of practical work. This influenced the participants' thinking and implementation beyond the project, as well as bringing concepts such as cognitive load theory into their work. The vignette below reflects these themes:

Vignette 2: Planning and using practical work

The importance of effective planning and use of practical work was discussed by teachers participating in the Journal Clubs project, following the discussion of an article by Millar & Abrahams (2009) focused on the value of practical work. This appears to have resulted in changes being implemented around the use and delivery of practical work as highlighted by two of the Journal Clubs participants:

> *One of the little things within the school is that we've been working on restructuring one aspect of year nine - the GCSE... I've been looking at how to embed some research into that… thinking about the kind of cognitive load aspect that has been pulled in there –* [and] *the sequencing,* [and] *the effective use of practicals. All of those have been put into*

it so [I'm] *facilitating a collaborative approach towards that planning and the sequencing of lessons, which has been going quite well* – Teacher 8, Journal Clubs

What I've done… as a head of department, is taken all the practical work that we do and looked at it in a bit more detail, as to why we're doing it, what we're doing and what we're trying to get out of it… I took the article on cognitive load theory as well, I put that… into our practical tasks, especially with sets of instructions... I'm trying to think from the pupil's point of view rather than the teacher's point of view on what would they class as complex or not. We're giving them integrated instructions… there are visual cues, to show them what to do as well as text saying, telling them what to do. - Group Interview 8, Journal Clubs

Scientific vocabulary

There was insufficient qualitative evidence to draw any conclusions about improving pupils' scientific vocabulary.

Supports for pupils' self-directed learning

There was insufficient qualitative data to present findings regarding 'supports pupils' self-directed learning. This was not a topic or theme that was a direct focus within the projects' materials. One of the articles supplied through the Journal Clubs project did focus on Inquiry-based approaches vs direct instruction but this did not lead to participants discussing it as an influence on their incorporation of self-directed learning into their practice.

Structured feedback

The factor analysis did not identify one single 'feedback' outcome measure, so Table 10 shows change-over-time results for the individual items that appeared in the survey related to this practice. All of these items were designed to be aligned with the recommendations related to providing structured feedback in the EEF's *Improving Secondary Science Guidance Report* (Holman and Yeomans, 2018).

Only three of the seven items showed a significantly positive change between baseline and endpoint. The other items showed a very slight positive movement, but none were statistically significant. Additionally, the magnitude of change across the three statistically significant items was relatively small, ranging from an effect size of 0.147 for item 2 (peer feedback), through 0.170 for item 4 (guided responses) to 0.227 for item 3 (small quantities of feedback) so, while there are some indications that the programme may have contributed to the participants changing how they supported their pupils via effective feedback, the evidence for this is not particularly strong. The participant interviews and group interviews did not provide any further insights into the contribution of the project to their feedback practices. In fact, the topic of feedback was rarely mentioned and not a key focus of any of the projects.

On balance, both the quantitative and qualitative evidence related to changes in science pedagogy appears positive.

It is important to remember that our survey items were developed from recommendations in the EEF's *Improving Secondary Science Guidance Report* (Holman and Yeomans, 2018). With this in mind, we asked a survey question to explore the participants' awareness of this guidance at baseline and, again, at endpoint. It is notable that the awareness was far greater by the end of the programme compared with the start; for example, while almost half (48%) of the respondents had 'never heard of' the guidance at baseline, by the endpoint, this figure had reduced to just one quarter (26%). Similarly, the proportion of respondents who said that they had 'heard of the report and used it to inform their science teaching' increased from 23% at baseline to 38% at endpoint (see Appendix 6 for full details). This suggests that the projects played a role in raising awareness among their participants about the EEF guidance. This was particularly the case for the Evidence in Action project, where the EEF report was linked to during every training session and referenced on all lesson plans. In turn, this appears to have had a positive impact on science pedagogy.

Table 10: Change over time on individual survey items related to providing feedback

Items The teacher…	Baseline Mean	Endpoint Mean	Difference	95% confidence interval of the difference	Significant difference? (p-value)	Effect size (Cohen's d)	95% confidence interval of the effect size
1. uses a variety of approaches to find out what pupils know and understand	3.98	4.01	0.028	0.093-0.148	No (0.651)	0.034	0.112-0.179
2. gets groups of pupils to look at the responses of each group member and assess the strengths and weaknesses of each	2.54	2.69	0.155	0.000-0.309	Yes (0.050)	0.147	0.000-0.293
3. offers small quantities of feedback at a time	3.60	3.78	0.183	0.066-0.299	Yes (0.002)	0.227	0.081-0.372
4. guides pupils on how to respond to their feedback	3.47	3.62	0.156	0.023-0.289	Yes (0.022)	0.170	0.025-0.314
5. uses comments to show pupils how they can improve	3.73	3.79	0.060	0.064-0.183	No (0.342)	0.070	0.074-0.215

Items The teacher…	Baseline Mean	Endpoint Mean	Difference	95% confidence interval of the difference	Significant difference? (p-value)	Effect size (Cohen's d)	95% confidence interval of the effect size
6. identifies common areas of misunderstanding and gives feedback on these to the whole class	4.03	4.13	0.098	0.07-0.224	No (0.123)	0.115	0.031-0.260
7. uses clues and pointers in written feedback to support improvement	3.45	3.49	0.048	0.099- 0.196	No (0.519)	0.047	0.096-0.191

5.4 School and wider outcomes

Headline findings

- There was some perceptual evidence that project participation led to increased engagement with and use of research and/or research-informed resources across departments and/or teams. This outcome was strongest in the project that had recruited whole departments or teams.
- There were very few reports of changes being brought about at the school level or across schools as a result of project engagement. Participants considered it too early to identify any pupil outcomes.

Departmental and team outcomes

Some departmental or team outcomes were attributed by interviewees to participation in the Journal Clubs, Evidence in Action and Teacher-led RCT projects. This was not an intended focus of the Research-2-Practice project.

The responses of the Evidence in Action interviewees were particularly positive, which may be a consequence of teams from the same school attending the training. Some of the interviewees reported a willingness to change their department's strategies in order to see if they worked. The project was perceived by some interviewees as bringing research to the fore in their department, '*opening the door to some people on research*' (Teacher 3, Evidence in Action) and bringing '*research into … our collegial conversations in school*' (Teacher 5, Evidence in Action). Other interviewees noted that teaching the lesson plans at the same time had meant they were able to discuss the materials and engage with the research as a whole team or department. There was also evidence that resources from the Evidence in Action project were being embedded in science departments – '*the main thing is that we are going to use the resources again next year'* Teacher 2, Evidence in Action.

A further example of departmental outcomes was provided by a teacher on the Teacher-led RCTs project, who reported that teaching numerical skills across the science curriculum had changed as a result of their involvement in the project.

A few of the interviewees reported that any pedagogical or curricula changes needed to be agreed with their senior leaders before being implemented. Others were using research strategically, as a lever to justify pushing forward significant department change, as illustrated below:

> *It really has given us a lot of ammunition to try and push through changes on a larger scale and say 'look, this is why we are doing it this way' in the department because here's some evidence.* - Group Interview 1, Evidence in Action

Vignette 3, drawn from three longitudinal interviews with a participant in the Evidence in Action project, traces how engagement with the project led them to re-engage with research and the positive impacts of this on their department's engagement with and use of research.

Vignette 3: Individual and departmental outcomes

By the end of the Evidence in Action project, this Head of Physics spoke more confidently about pedagogical research, engaged regularly with the research-informed resources from the project, intended to continue using them, and had transferred approaches from the project across their department.

Although motivated to join because they '*value*[d] *research in education and want*[ed] *to know if we can do anything better'*, at the start of the project, the participant only interacted with research that had been '*trickled down'* to them by others. By the end of the project, they reported directly accessing pedagogical research in the EEF Teaching and Learning Toolkit and on the IOP website. This participant commented that:

> *It's nice to be reminded of what the research is, where it is, how easily accessible it is and, therefore, you know, have a real emphasis on the staff that I lead or otherwise can help in the department.*

The participant estimated that they now accessed new research roughly once a month, which was a considerable change. Their increased engagement with research also impacted on their departmental colleagues. Prior to participation in the project, the collaborative discussions about pedagogy in the department had centered on sharing blog posts and personal experiences. During the project, all of the teachers in the department accessed and applied the provided lesson plans and associated resources, finding them to be of high quality. Acting as a conduit for professional discussions, interaction with these resources led the Head of Department to state:

> *I've delivered some CPD to our staff… where I really explained what this new approach was, why that new approach needed to be taken… and given some… strategies for that, and then we tried to… implement… those ideas in the lessons.*

There were indications that research use would be sustained in this department, with the Head of Department recognising that *'before we'd maybe assumed* [that the staff] *knew more* [about research] *than they actually did'*, and '*in the future to... train staff and get them to* [engage with the EEF Teaching and Learning Toolkit and IOPSpark website] *because it's so easy to digest'*.

Whole-school outcomes

There were few reports of outcomes of change across (as opposed to within) teams or departments. One Journal Clubs interviewee noted that they hoped to start an in-school club and also that the project had led to discussion with the Head of Mathematics around research use.

Pupil outcomes

There were some reports, particularly from the Evidence in Action participants, of positive responses from pupils to the research-informed lessons. There was, however, there was general agreement that it was too early to identify any specific benefits that this enthusiasm might have had in terms of pupils' academic outcomes.

Wider outcomes

There was very limited evidence of the projects leading to cross-school or other wider outcomes, although a few participants intended to share their learning from the projects more widely:

> *I'd like some colleagues in the other junior school, in our multi academy trust, to participate, and, actually, make sure that it feeds into an annual professional learning cycle for other colleagues.* - Teacher 3, Teacher-led RCT

5.5 Projects' future plans

Headline finding

- All of the projects were keen to further develop their projects, and some were making their resources freely available, but detailed plans were not in place at the time of the final project team interviews.

One aim of the Wellcome programme was to support the development of successful sustainable projects. At the time of the interviews long term plans were still developing. Shorter term plans for some projects included maintaining contact with the project participants and making project resources available and/or publicising their already freely-available resources.

The Research 2 Practice project team were planning an event for the start of 2021/22 academic year for mentors and the new cohort of trainee teachers from the three universities in the project consortium. They were also looking at other ways to publicise their freely available online resources. The Journal Clubs project lead had begun to think of ways to make the training and resources available to Chartered College of Teaching members and other teachers. They were also considering introducing the idea of Journal Clubs to some of the existing networks run by the Chartered College of Teaching and either hosting an article for the month on their website or creating a database of Journal Clubs articles. Other plans for the online Journal Clubs format were also developing.

The Evidence in Action project lead was planning to maintain contact with the participants, where possible, to support the use of the lesson plans and remind them of the three research summaries that were used throughout:

> [I'm going to] *send out an email shortly in which we're going to be feeding back to teachers* [the] *ideas they came up with on how to support themselves and colleagues to use research in their practice.* – Project Lead Interview 2, Evidence in Action

It was also hoped that the Evidence in Action project could be developed to the point where it was suitable for a RCT.

The Education Development Trust and STEM Learning were looking to build on the positive relationship established through their partnership on the Teacher-led RCT project, which had brought together research and science pedagogy expertise. As the STEM Learning lead noted, extending the teacher-led RCT project to more science teachers would enrich the other CPD programmes that STEM learning offer, as meta-analyses of the teachers' results would build a stronger evidence-base about effective science practices. For the Education Development Trust this project formed part of a continuing wider programme of national and international work to support teachers to engage with a clinician practice model of professional development and build an evidence base on effective classroom practices.

Summary of findings

Participant outcomes – Research use

The survey identified a statistically significant positive relationships between the respondents' involvement in the programme and their confidence in accessing, assessing the quality of, and applying research and between programme participation and use of research in practice.

Participant outcomes – Science pedagogy

The survey detected a statistically significant positive relationship between participants' involvement in the programme and enhanced science pedagogical practices. There was strong supporting qualitative evidence of participants implementing research-informed strategies and resources for supporting metacognition, self-directed learning, retrieval practice, and addressing scientific misconceptions.

Other outcomes

There was some qualitative to indicate that project participation had enhanced research engagement and use in interviewees' departments and/or teams. This outcome was strongest in the project that had recruited whole departments or teams.

Limitations

The outcomes findings may present a somewhat optimistic picture. This is because they rely on self-reported data, projects generally recruited teachers with a positive orientation towards research use and drop-out rates from the projects were high. In addition, there was survey attrition, so the final sample size was relatively small. Nonetheless the outcome findings are encouraging.

The absence of a counterfactual means that causal claims cannot be made.

Chapter 6: Participant engagement and retention

Chapter 6 draws on MI and qualitative data to findings on:

- Participant engagement and retention patterns
- The COVID-19 and school factors that impacted on participant engagement, retention, and implementation of learning.

6.1 Participant engagement

Headline finding

- The levels of engagement in project activity declined over the programme period.

Among the participants who were retained across the four projects, engagement was somewhat variable. The percentage of participants reported as '*fully*' engaged across all four projects dropped by varying degrees over the course of the programme delivery. Across the Evidence in Action and Journal Clubs projects (which were delivered over the autumn, summer and spring terms 2021), the percentage of '*fully*' engaged participants fell from 57% (autumn term) to 34% (spring term) then 25% (summer term). The percentage of participants reported as '*not at all engaged*' in these two projects only increased slightly over the same period – increasing from 14% (autumn term) to 18% (spring term) then 19% (summer term).

The Teacher-led RCTs and Research-2-Practice projects were both delivered across the spring and summer terms 2021. For Teacher-led RCTs, the number of '*fully*' engaged participants and '*not* at all' engaged participants remained relatively stable over both terms of delivery. For Research-2-Practice, the number of '*fully*' engaged participants fell from approximately 16% to 0%. Research-2-Practice also reported having no participants who were 'not at all' engaged in the spring and summer terms.

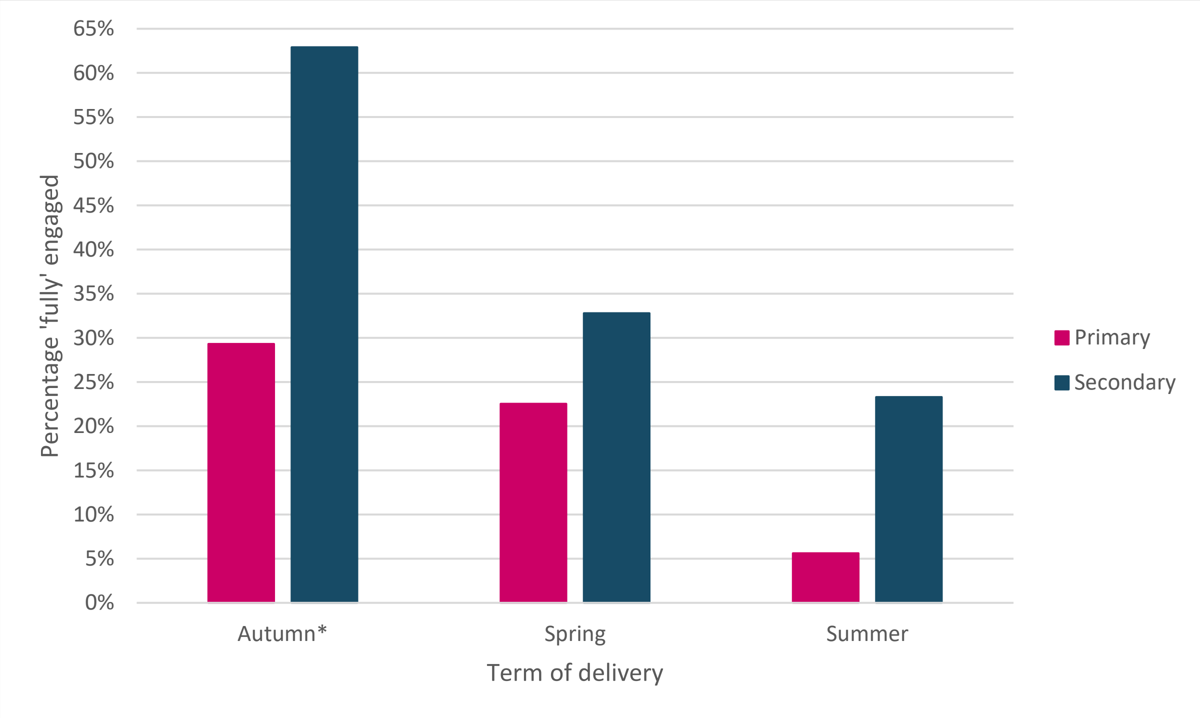
We also calculated the proportion of participants rated as having persistently high or low engagement levels over the year - 29% were '*fully*' engaged during two or more terms[30] of their project's delivery, while 12% were 'not at all' engaged during two or more terms of their project's delivery.

Figure 4 shows that the proportion of participants considered '*fully*' engaged decreased to a great extent across both primary and secondary schools. Among secondary schools, 63% were

[30] This includes participants who were reported as being 'fully' engaged in non-consecutive terms.

rated as '*fully*' engaged by the providers in the autumn term compared to 33% in the spring term, with 23% by the summer term. Among primary schools, 29% were rated as 'fully' engaged by the providers in the autumn terms compared to 23% in the spring term, with just 6% in the summer term.

Figure 4: Proportion of participants who were 'fully' engaged by phase



*Engagement data were only available for two of the four projects during the autumn term (n=314). Data were available for all four projects in the spring and summer terms (n=468).

6.2 Participant retention

Headline findings

- By the end of the academic year 2020-21, 88 of the 468 programme participants (19%) had formally withdrawn.[31] This figure is likely to be an under-estimate, as the design of one of the projects meant that it was not feasible to record withdrawals.
- A greater proportion of primary than secondary participants formally withdrew (25% compared to 16%).

The proportion of participants who withdrew varied by project, ranging from 12% to 26%. In addition to these formal withdrawals, it appears that a small number of participants did not

[31] Formally withdrawn participants were those who notified their project that they would no longer be participating in the project.

engage with their project at all. Just under 6% of participants were rated as '*not at all*' engaged by their provider during every term of their project's delivery.[32] While the Research-2-Practice team recorded how many mentors engaged with the initial training, they could not collect further data around engagement, as the project design did not include ongoing engagement with mentors, so they chose to record participants (either trainee teachers or mentors) who had not formally withdrawn as '*working independently*'. As a result, it is likely that the proportion of participants apparently retained on this project is overstated.

For the Evidence in Action and Journal Clubs projects, it was possible to investigate whether the composition of the retained participant group and withdrawn participant group differed notably.[33] The structure of the Research-2-Practice and Teacher-led RCTs projects was such that they were unable to collect these data or had limited success in this respect. The full analysis results are available in Appendix 4. They show that:

- for Evidence in Action, a notably high proportion of classroom teachers formally withdrew from the project compared to those who were retained. This may have been due to school leaders signing their teachers up for the project
- for the Journal Clubs project, a high proportion of primary teachers formally withdrew; there was evidence from the interview data that some primary teachers thought the papers were less relevant to them. Higher withdrawal rates for primary teachers were also noted by a Teacher-led RCTs project lead in early 2021
- for the Journal Clubs project, a high number of science subject leaders withdrew compared to a relatively small number of classroom teachers. There are no qualitative findings that explain this finding, but it may reflect additional pressures on subject-leaders due to the impact of the COVID-19 pandemic.

With reference to higher withdrawal rates among primary teachers, it is possible that the pressure for English and mathematics '*catchup*' meant that science content was side-lined. In addition, the partial school closures in January 2021 also marked the first time that primary schools were expected to deliver hybrid teaching, with some students in the classroom and others learning from home. Whilst some secondary schools had already adapted to this approach during earlier periods of partial school closures, primary schools may have found it more difficult to deliver hybrid teaching at this time.

[32] For Evidence in Action and Journal Clubs, the project activities were delivered over three terms. For Teacher-led RCTs and Research-2-Practice, the project activities were delivered over two terms.

[33] The following characteristics were compared for withdrawn and retained participants: phase, participant job role, years in teaching, main subject taught and (for Journal Clubs only) project role.

6.3 Factors affecting engagement, retention and implementation of learning

Headline finding from the qualitative analysis:
- Engagement, retention, and implementation of learning in school were all impacted negatively by the pressures of the COVID-19 pandemic and its impact on schools.
- Senior leader support; time to engage with, and apply learning from the project in school; and a collaborative school culture that enabled teachers to adapt their teaching plans and resources supported research use.

This section reports the COVID-19 pandemic and school factors that were reported to have impacted on participant engagement, retention and implementation of learning.

Impacts of the COVID-19 pandemic

Engagement and retention

The pandemic clearly had a significant impact on engagement and retention across the projects. The project teams noted that most teachers that dropped out did so because of pressures due to the pandemic. Several interviewees noted that teacher illness and self-isolation, and the knock-on effect of this on other staff, had an impact on engagement. The COVID-19 pandemic also exacerbated existing time and workload pressures on teachers (see school factors below).

Implementation of learning from projects

Participants commented that implementing learning from the projects was difficult due to the impact of COVID-19, meaning that it had not been a priority, was limited in scale, or had not been managed at the time of interviews. One participant noted '*Some of the research suggestions and conclusions and recommendations, we just couldn't put into place*' (Teacher 5, Journal Cubs). A few interviewees reported that the need to recap on the learning that took place during lockdown or implement the '*catch-up curriculum*' meant that there was limited time for science lessons. It was also the case that some of the subjects covered in the projects did not feel relevant during a lockdown period, for example inquiry-based learning.

COVID-19 had an impact on science practical work, which in turn limited the opportunities for participants to implement some of their learning and research-informed resources from the projects. Remote practical work was felt to be very difficult; for example, it was felt to be unreasonable to ask of parents to gather the required resources. When students returned to school, and classes were 'bubbled' and in-school movement restricted, and it was sometimes not possible to use laboratories. While some teachers were able to find solutions, this had a knock-on impact on student learning and engagement and what was achievable by teachers in terms of implementing what they had learned.

> *In the end we had to go out and buy a few hundred pounds worth of kit to then push round the school to get to the lessons, that then takes longer and has a knock-on effect for the learning.* - Teacher 3, Evidence in Action.

Equipment that was shared between year groups had to undergo periods of quarantine before being used by another group, which created situations where equipment was limited, or classes needed to take place within a short timeframe.

Participants also reported that schools had to reduce the amount of movement within classrooms or laboratories (if it could be used), which meant that the way in which practical work was structured was different, i.e., students facing the front, with no or limited group work. The need for social distancing created logistical challenges for using project lesson plans, implementing other aspects of learning from the projects and eliciting student responses. Alternatives to practical work, such as the online PhET simulation suggested by Evidence in Action, were reported by interviewees to be useful.

Wider dissemination of learning from projects

Participants were less able to disseminate and discuss their work on the projects with colleagues as a result of the COVID-19 restrictions, and the limit on how many people could meet face-to-face, as well as the pressure on in-school time. One teacher noted '*I suppose not being given time to discuss… in staff meetings for the research that I'd read. That was quite limiting*' (Teacher 4, Journal Clubs). Illness and absences due to isolation periods also exacerbated the lack of opportunities for dissemination, in addition the pressure that teachers were under, as already noted, also made this difficult.

Other

Illness and absences due to isolation periods exacerbated the lack of opportunities for dissemination. In addition, the pressure that teachers were under, as already noted, also made this difficult.

School factors

Time pressure and workload

The most frequently mentioned barrier to engagement with the projects was time. Depending on the nature the project teachers were expected to: prepare for and attend sessions; create or adapt lesson plans and/or resources, use resources or implement a trial. Many teachers were unable to find the time to do this within the school day, meaning that much of the work had to take place in teacher's own time. Attending training sessions was also challenging for teachers in terms of the time needed, because of commitments both inside and outside of school.

> *Work timings just made it quite difficult to… to put aside enough time to … get the most out of doing the training and things like that* – Group interview 8, Journal Clubs

> *There was nothing in school that was hindering me other than just been busy.* - Mentor 7, Research-2-Practice

> *I suppose not being given time to discuss with staff, in staff meetings for the research that I'd read. That was quite limiting.* - Teacher 4, Journal Clubs

Teachers being stretched in terms of time is not unusual (Higton et al, 2017), however the lack of time was further exacerbated by the COVID-19 pandemic, and the associated increase in workload. Increased workload arose from the impact of staff illness/isolation, and the having to recap work covered during remote learning, due to concerns over lower engagement with remote lessons.

Some participants reported that their school leader had adjusted their workloads to free up the time needed to participate in their project. However, one teacher noted that while the headteacher was initially quite supportive of their engagement in the project '*I don't think he quite realised how much extra time was involved in it*' (Teacher 4, Journal Clubs).

School leader support

On-going senior leadership support was found to be important for project participants, for example by giving teachers the time and space they needed to engage with projects, showing an interest in the learning taking place and via discussions about progress and outcomes. One teacher commented:

> *They [*school leaders*] want the school to be [a] more and more forward-looking research-based school, so they were completely behind us, you know, very supportive, liked the idea, checked up on us, wanted to know how it was going, wanted us to evaluate it, you know, very supportive SLT.* - Teacher 3, Evidence in Action

Engaging in a project as a leader was clearly an enabling factor, with one participant commenting '*the application of the learning was done within my own department and I'm head of department so we just got on with it'* (Teacher 1, Journal Clubs). Colleagues being willing to engage with the project was also noted to be helpful.

School culture and processes

The qualitative data indicates that school cultures were influential in determining the extent to which teachers were able to engage with the projects and implement their learning. When interviewees had the autonomy to decide what topics to teach, and how and when this would take place, they were more able to adapt their teaching plans to implement learning, lesson plans and/or resources provided by the projects. For example, teachers noted that they were able to adapt the scheme of work to include project resources, stating '*it was easy to swap the topics around*' (Teacher 2, Teacher-led RCTs), and '*our lessons are pretty much centrally planned, so when we were taking part in this project… that sort of fed into one set of lessons that were uniform for the students'* (Group interview 1, Evidence in Action).

A culture of collaboration was also found to be conducive to implementing learning. Across all projects there were some accounts of participants drawing on learning and resources from the projects to collaboratively develop and implement pedagogy and curricula with colleagues (see Sections 3.3 and 3.4). An existing culture of collaboration in school was helpful in realising these broader changes. For example, one Evidence in Action interviewee noted that:

> *We looked at it one lesson at a time… [I went] through a particular lesson with myself and with other staff about what the structure was, what it entailed, what was required and the reason behind it…So that was quite useful because… it started us talking about the research.* - Teacher 3, Evidence in Action

Collaborative planning process appeared to facilitate the adaptation and implementation of research-informed resources, as Illustrated by an Evidence in Action interviewee:

> *Our lessons are pretty much centrally planned, so … taking part in this project…fed into one set of lessons… and… allowed us to really focus on electricity as a CPD topic for … a good few weeks… where we actually have meetings and further discuss electricity and how to teach it,* – Group Interview 1, Evidence in Action

Staffing

Engagement and retention were impacted by was staff leaving schools, or changing roles, and trainee teachers completing placements, for example:

> *Early on in the project, the other physics teacher also achieved a Head of Year role, so that really limited sort of the time they had after school, to participate.* - Teacher 1, Evidence in Action

We lost two members of staff and had to replace them. Teacher 2, Evidence in Action

Summary of findings

Engagement declined over the course of the projects and a significant number of participants withdrew from the programme.

Engagement and implementation of learning were impacted negatively by the pressures of the COVID-19 pandemic. Time and workload, exacerbated by the COVID-19 pandemic, were the main barriers encountered by interviewees. Engagement and implementation of learning were enabled when school leaders made arrangements to free up teachers' time and in schools where there was culture that supported collaborative planning and enabled teachers to experiment with their practices.

Chapter 7: Conclusions and implications

Chapter 7 concludes the report by:

- summarising the outcomes of the programme on teachers' research use and science pedagogy
- drawing out learning about:
  - how teachers use and broker research
  - how CPD providers can effectively broker research use
- suggesting ways in which policy-makers, funders, other national organisations and schools can support the scaling-up of teachers' engagement with and use of research, in order to improve science teaching
- indicating directions for future research.

7.1 Context

The Wellcome programme was delivered during an atypical time for the school system. Partial school closures, remote teaching, restrictions when schools were open, and other impacts of the COVID-19 pandemic placed unprecedented demands on teachers and schools. For most of the participants, this restricted the time they had available both to engage with their project and to implement or carry out research. Necessary changes to lessons, such as the removal of practicals, further impeded the opportunities for using and doing research. For project teams, this meant that project recruitment and maintaining participant engagement was challenging. In total, 468 science teachers were recruited, which was 77% of the intended target, but there was notable drop out over the duration of the programme. Project timelines and activities were adapted in response to the changing context. The research study was also impacted, timelines were changed, engaging participants in data collection activities was challenging, and there was attrition in the endpoint survey and longitudinal interviews.

In interpreting the findings of this report, it is important to note that the survey and qualitative analyses indicate that most of the participants had a positive orientation towards research use before they were recruited to the projects.

7.2 Programme outcomes

Despite the challenges faced by the participants and projects, a statistically significant positive relationship was found between the participants' involvement in the programme and the following outcomes:

- confidence in:

- accessing, assessing the quality of, and applying research
- using and applying research evidence
- designing, implementing, analysing small-scale classroom RCTs, and supporting others to do so[34]

- using research evidence in their practices
- science pedagogical practices becoming more closely aligned with research evidence on:
    - supporting pupils to challenge misconceptions and review their learning
    - using practical work purposefully
    - using models to support understanding
    - using practices that support the retention and retrieval of knowledge
    - helping pupils to develop scientific vocabulary
    - supporting pupils to direct their own learning.

Although, in the absence of a counterfactual it is not possible to claim that a causal link exists between project participation and these positive outcomes, most interviewees self-reported similar outcomes and attributed these to their project participation.

Some interviewees, particularly team or department leaders, attributed positive team or departmental pedagogical or curricula change outcomes to the project. Very few reported wider outcomes across a group of schools.

As expected, the extent of individual, team/department and wider outcomes was perceived by participants to have been limited by the COVID-19 pandemic. Many participants were planning to embed their learning from the projects further in the future.

The survey and qualitative outcome findings may present a slightly inflated picture of positive change, as: they rely on self-reported attitudes, behaviour and practices; the projects mostly engaged teachers with a positive orientation towards research use; and drop put from the projects was high. Nonetheless, the outcome findings are encouraging and particular given the constraints of the COVID-19 pandemic.

As Gorard et al. (2020) rightly point out, relying solely on single project outcome findings to inform policy and practice should be avoided. While this study is not of the scale or type of meta-synthesis that they advocate, the aggregation of the outcomes data from four distinctly different projects does add some weight to our findings on the effects of teachers' using or carrying out research. In addition, the survey findings are consistent the qualitative findings. We also acknowledge the limitations arising from being unable to adopt a counterfactual design and the sole reliance on perceptual data to assess school and wider outcomes.

[34] Only participants in the Teacher-led RCTs project were asked questions on confidence in doing research.

7.3 Learning about how teachers engage and use research

Rickinson et al. (2020, p. 5) define the quality use of research evidence in education as '*the thoughtful engagement with and implementation of appropriate research evidence, supported by a blend of individual and organisational enabling components within a complex system*' (p5).

In line with their aims, the four Wellcome projects offered differing opportunities for 'thoughtful engagement'. As the findings illustrate, the Journal Clubs participants generally engaged with primary sources, following a series of structured steps to critically appraise the methodology, gain an in-depth understanding of the content of the source, and plan the implementation of the research findings in school. In contrast, participants in the Research-2-Practice and Evidence in Action projects engaged primarily in adapting and implementing research-informed resources. These were linked to research that had been curated for them, in terms of research quality and relevance to practice (in both instances focusing on difficult-to-teach topics). The Teacher-led RCTs participants engaged with research, sometimes primary sources and sometimes research-informed resources, that were directly connected to the focus of their trial, during the early stages of their project.

A particularly interesting qualitative finding was that in-depth engagement with research, for example the critical appraisal of academic papers, did not appear to be any more likely to research being used instrumentally in school to change practice. than adapting research-informed resources. While there were indications that conceptual research use was integrally bounded with instrumental research use, it was beyond the scope of this study to explore any differential effects on conceptual research use in schools. The study was also time-limited, so it was not possible to ascertain whether in-depth engagement with research leads to greater instrumental and/or conceptual use in the longer term.

Also of note is that, as hypothesised, participants did not necessarily engage in a linear process of accessing research, followed by engaging with the research, before translating it to inform practice then implementing research-informed ideas and/or resources in schools. For example, there were a few instances where Evidence in Action participants reported starting by implementing research-informed lesson plans, then returned to consult the research summaries to find other research that could inform their practices. This aligns with a conceptualisation of teacher-learning as a complex, non-linear process, and points to the need for a range of different CPD opportunities to be made available to teachers. The findings also indicate that sustained change in research use is most likely to be realised in schools that have a collaborative culture, where teachers discuss research and research use with colleagues and are enabled to experiment with their practices.

7.4 Learning about how CPD providers can effectively broker research use

One aim of the Wellcome programme was to support the development of successful, sustainable CPD programmes. As reported in Section 5.5, all the projects have plans to extend their work, subject to securing future funding, and some have already made their resources available more widely. There is also learning to be drawn from this study for other CPD providers, who aim to broker research use.

The projects involved in our study were diverse, and we did not aim to compare them or identify one uniquely promising brokerage model. As highlighted in the previous section, and more broadly in the qualitative findings, there appears to be value in teachers being offered different models of research brokerage to support research use, to suit individuals' interests and needs, and support sustained research use.

The time-pressed teachers participating in this project clearly valued the ease of tweaking research-informed lesson plans and associated resources to suit their context. This seems a promising approach for widespread scaling-up. This study indicates that the success of such a scale-up would depend on CPD providers' ability to broker the development of research-informed resources that: draw on, and are linked to, topic-specific, broader science and cognitive pedagogical research; align with the National Curriculum; and are easy to integrate into curricula planning. In line with other studies (e.g., Saunders, 2010), brokering the co-construction of such resources by researchers and experienced teachers in this programme, particularly at scale, prior to use with the project participants, was found in this project to be a challenging, and time-consuming process. Learning from this project indicates that brokering can be effective when: it gives equal weight to researcher and teacher knowledge; there are clear expectations and training for researchers and teachers; and regular interactions between the actors to share understanding of research and practice and produce packages of research-informed resources.

As in this study, some teachers are likely to be interested in, and motivated by, engaging in opportunities for more in-depth engagement with research. The Journal Clubs project demonstrated that teachers' engagement with, translation, and use of research in school can be effectively facilitated through structured discussion and the provision of support tools, in an environment that enables teachers to share ideas and discuss the relevance to their school context. While more in-depth engagement with research is time-consuming, this approach has the potential to develop in-school research leaders as well as raise the levels of research literacy in schools.

Undertaking pedagogical research can be attractive to some teachers. For some of the participants in this study, carrying out their own research was highly valued, as it was aligned with their beliefs, developed during their prior science education and/or professional career, about the importance of using scientific methods to generate and test knowledge; in this case, knowledge to inform practice. The Teacher-led RCT project showed that providing teachers with a structured programme and high-quality resources, together with support from research and science pedagogy experts, can be effective in supporting teachers to carry out research. In addition to supporting teachers' research use, the project has the potential, at scale, to add to the evidence base of effective pedagogical practices through conducting meta-analyses of the teachers' results in relation to specific pedagogical practices. This was not realised by the end of the project because of the limited number of trials completed and limited opportunity for teachers to undertake replications, due largely to the impact of the COVID-19 pandemic. Previous work by the project team, however, indicated the feasibility of the approach (see: Brown, 2022; Churches et al., 2020a and 2020b).

A further consideration for CPD providers brokering research is the composition of the groups which whom they work, and how best to tailor their approaches to suit different types of participants. For example, the Research-2-Practice project illuminated differences between trainee teachers' perceptions of, and engagement with, research and research-informed resources and those of their mentors. Significant scaffolding appears to be required to enable trainee teachers to engage with research and adapt research-informed resources for practice. Findings from the projects that recruited both primary and secondary teachers indicate that CPD providers should pay attention to the relevance of programmes for primary teachers.

Box 8 sets out the key features of CPD design and delivery that were found to support teachers' research use:

Box 8: CPD design and delivery features that support teachers' research use

- An integrated package of support, including training, high-quality resources and 1:1 support, which is made available in a timely way to enable implementation of research use that is compatible with the school curricula and the pattern of the academic year.
- Regular training or other project activity that is easily accessible and flexible; for example, sessions being offered more than once and/or recorded to enable catch-up, and the use of self-paced online training resources.
- Resources to support engagement with, the translation of, and implementation of research, that are structured to scaffold the processes.
- Research-informed resources that are: presented as an easy to adapt package of lesson plans with associated teaching and learning resources; focused on difficult-to-teach topics; informed by topic-specific, broader science and generic pedagogical research; and linked to the National Curriculum and the underpinning evidence.
- Regular opportunities for support, for example during workshops and other group meetings, drop-ins, and swift, comprehensive answers to queries and concerns raised on a one-to-one basis.
- Incorporating opportunities during project activities for planning and reviewing the implementation of research in school.
- Ensuring the relevance of project activities and resources to both primary and secondary science teachers in mixed-phase CPD and scaffolding learning for trainee teachers.

7.5 Learning about teachers' brokerage of research

Just as the project teams brokered research use for participants, so the participants, in turn, brokered research in their own schools – in what may be seen as a 'nested model of brokerage'. They brought ideas from research and research-informed resources into discussions, usually at the team or departmental level. In addition, they engaged colleagues in collaborative activity, where research was further translated and/or research-informed resources were adapted to develop curricula and pedagogy. In most instances this involved consideration of the underpinning research, and in all instances, the application of subject and general pedagogic knowledge, as well as knowledge about their school context. It was beyond the scope of this study to ascertain the extent to which fidelity to the evidence was maintained during such translation, and subsequent implementation.

Although the evidence is limited, partly due to the COVID-19 pandemic reduced the opportunities for the participants to broker research in their schools, the study indicates that teacher-led brokerage can lead to positive impacts on colleagues' pedagogy and school curricula.

The study also indicates that this wider use of research can only be fully realised within a school culture that nurtures research use. In line with other studies (see e.g., Brown et al., 2016; Coldwell et al., 2017), this included senior leadership backing, and a safe environment, time and autonomy for individual teachers and teaching teams to plan collaboratively for, experiment with, and review their practices.

7.6 Looking forward

As the preceding discussion illuminates, supporting teachers to engage with and use research has the potential to contribute to improving the quality of science teaching. It also highlights that a promising way for this to be achieved is through multiple and differing forms of research-brokerage by CPD providers at the meso level in the education system and associated brokerage by teachers at the micro (school) level. Realising this potential requires supportive action at the macro-level by policy-makers, funders, and other national organisations are able to foster the supportive conditions required for effective meso and micro level research brokerage.[35] We, therefore, suggest that, at the **macro level**, consideration should be given to:

Supporting the further development and testing of multiple and differing forms of CPD that broker research for teachers

In doing this, consideration would need to be given to how the different approaches may best fit within a teacher research use CPD 'marketplace' and engage teachers who are less committed to research; for example:

- *CPD focused on supporting teachers to implement, and broker with colleagues, research-informed resources* appears promising for rolling out at scale. This would ensure that as many science teachers as possible are using research-informed lesson plans and resources. Targeting difficult-to-teach topics would be valuable. This approach does come with risk and substantial set-up costs, however, in relation to the translation of research into research-informed resources.
- *Journal Clubs and similar forms of CPD for teachers* may be of particular relevance to teachers with a strong interest in research and/or who hold science, research use, or CPD leadership roles in school, or across, school networks.
- *CPD to support teachers who are interested in carrying out their own research* appears to appeal to science teachers, and when it engages those who are in a position to engage other teachers in research, either within their own school or science networks, it has the potential to have a wider impact on research use. CPD that is focused on supporting the implementation and replication of small-scale RCTs and incorporates a meta-analysis of

[35] Further elaboration of applying systems theory to aid understanding of, and the necessary support for, research use can be found in Maxwell et al. (forthcoming).

the teachers' findings has the additional potential to generate new evidence to inform practice.

Reviewing the best approaches to and options for investing in the translation of research into packages of research-informed science resources

Large CPD providers may have the knowledge, skills, and capacity to bring together researchers and experienced teachers to broker translation. This may not be the case for smaller providers, who could be well-placed to support the implementation of the resources. Broader consideration is needed of how researchers, teachers, and organisations, that are expert in curriculum development and the production of resources, can work together most effectively in order to translate research into high-quality easy to use resources that are relevant to practice and maintain fidelity to the research. This requires both orchestration and investment.

Ensuring that policy decisions and their implementation support the establishment and maintenance of sustainable research-use cultures in schools

In making policy decisions and setting school accountability measures, consideration is needed of the potential impact that this may have in terms of limiting school leaders' ability to nurture a positive research-use culture.

Furthermore, at the **micro level** of schools, realising the potential of both CPD-provider-led and teacher-led brokerage requires school leaders and departmental heads to:

Create the conditions for a culture that is conducive to teachers' research use

This includes creating opportunities, time and autonomy for teachers to experiment with research-informed practices and carry out their own research, as well as fostering a collaborative culture where there are regular opportunities to discuss research and plan research use with colleagues.

7.7 Future research

Further research is needed to extend the evidence-base on the impact of teachers' research use and the relative effects of different forms of brokerage. As well as measuring the related impact on teaching and pupil outcomes, the research should assess brokerage approaches in relation to the specific objectives of the CPD programme. As this study has shown, brokerage may usefully have different foci.

This study has contributed to illuminating the under-researched area of how teachers use research in schools. In doing so, it has inevitably raised questions for further study. Potential future lines of enquiry include whether or not there is a longer-term effect on research use and science practice when teachers engage with research in-depth, compared to engaging with research ’snippets’ and/or being provided with research-informed resources. The ways in which trainee teachers perceive, engage with, and use research is a further avenue for exploration, together with how CPD programmes can most effectively support their use of research.

The focus on subject-specific research use in this study has also raised important questions about the relative roles of topic- and subject-specific and generic pedagogical research when applied to practice in a subject-specific context. This area, too, requires further exploration.

A final area that both those who study research use and broker research are well placed to explore collaboratively is ‘What is a research-informed science teacher? What do they believe, think about, and do? Answering this question is key to answering how teachers can be supported most effectively to use research.

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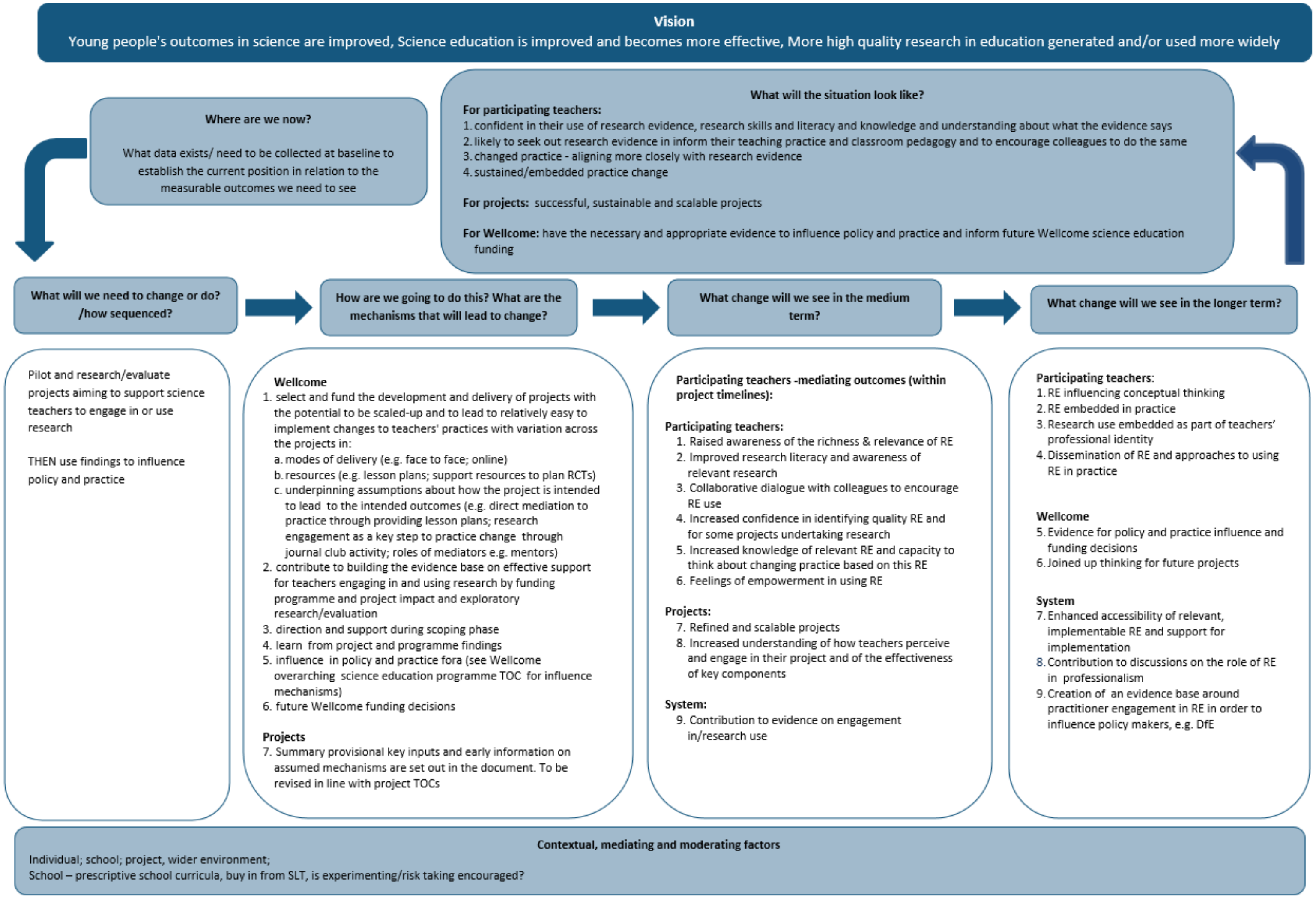
Appendix 1: The Wellcome Programme Theory of Change

Figure 5: Wellcome Programme Theory of Change



Appendix 2: Project Theories of Change

Figure 6: Journal Clubs Theory of Change

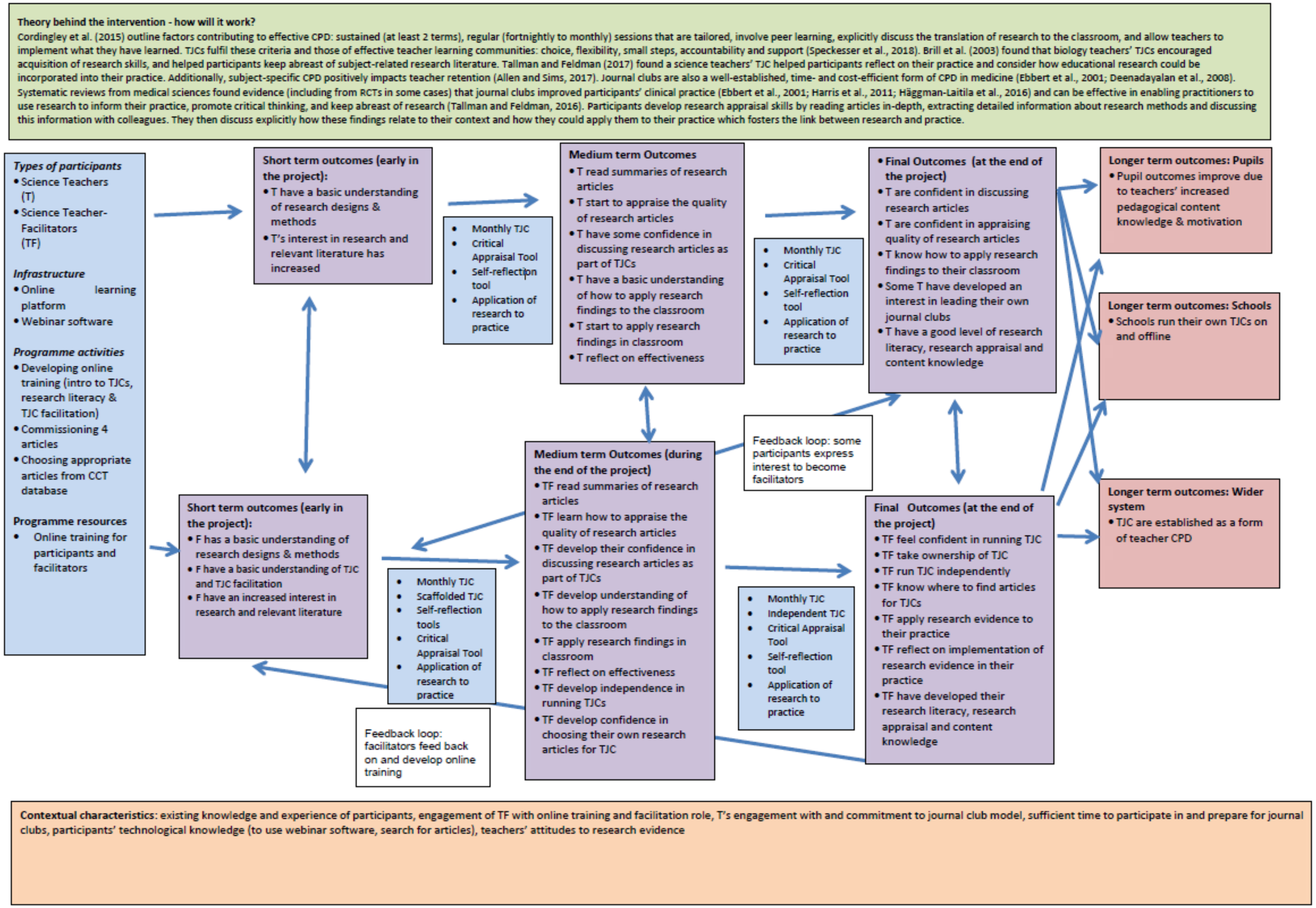


Figure 7: Research-2-Practice Theory of Change

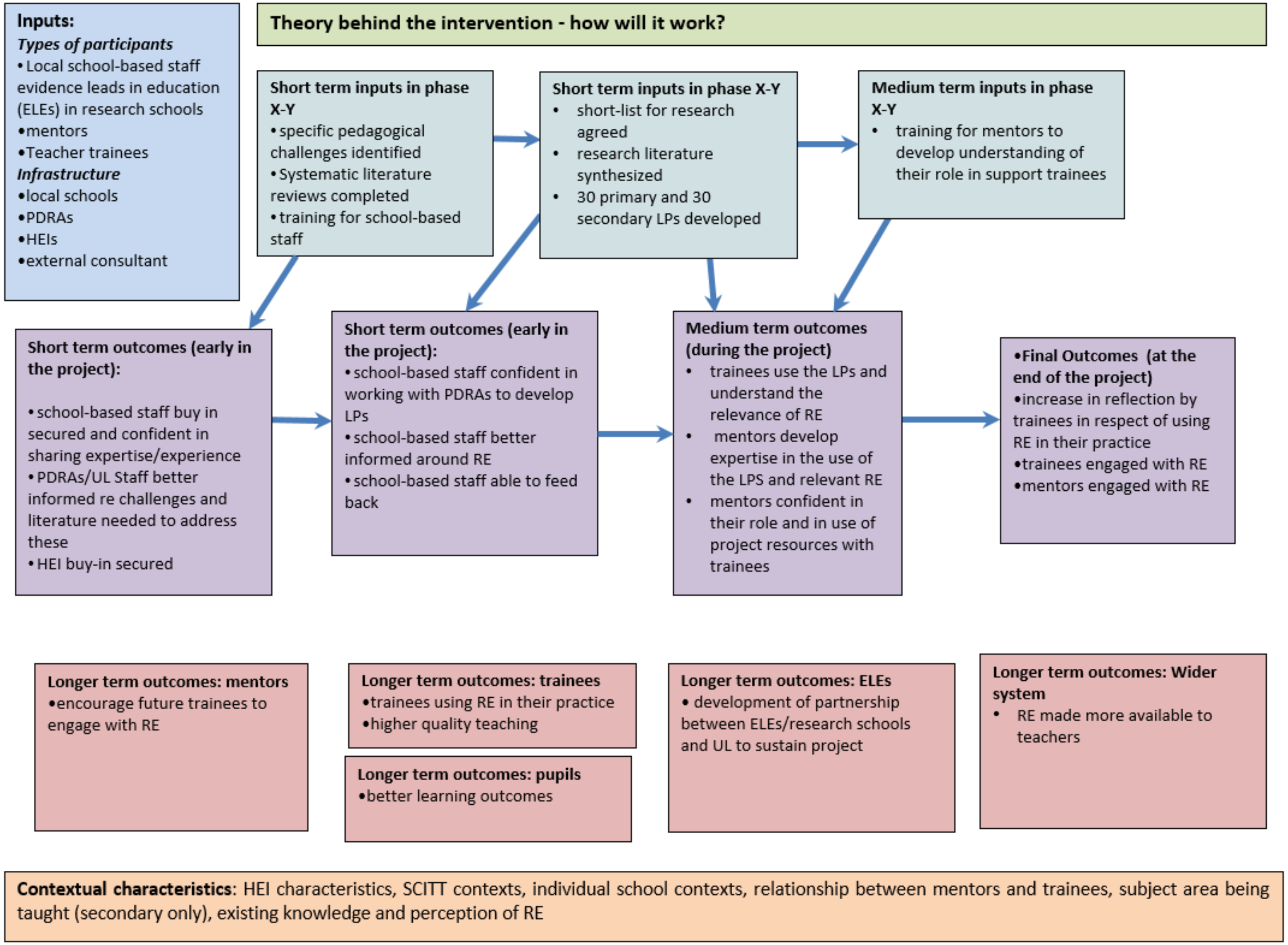


Figure 8: Evidence in Action – inputs and outcomes

<u>Inputs</u>

Repeated teacher training

Lesson plans:
-Annotations
-Clickable links

Email prompts for teachers to plan where, when and how they will incorporate RE in their practice

Email reminders to use RE and share it with colleagues

<u>Interim outcomes</u>

Teachers use the lesson plans

Teachers read and understand the evidence summarised in the plans

Teachers click on the links and read the underlying evidence

Teachers browse further evidence on linked research platforms

<u>Outcomes (during intervention)</u>

Teachers change their pedagogical practice (apply evidence in the classroom, using the plans)

Teachers' knowledge of evidence-informed content improves (subject and pedagogic)

Teachers' interest in research evidence increases

Teachers' access of research increases

Teachers' collaboration, in terms of encouragement of colleagues to use research evidence, increases

Teaching quality improves

<u>Outcomes (after intervention)</u>

Teachers change their pedagogical practice (i.e., engage with evidence more often and incorporate evidence in their own plans, subsequent to the intervention module)

Teaching quality improves

Teachers' collaboration, in terms of encouragement of colleagues to use research evidence, increases (applies to both during and after the intervention)

Figure 9: Evidence in Action Theory of Change

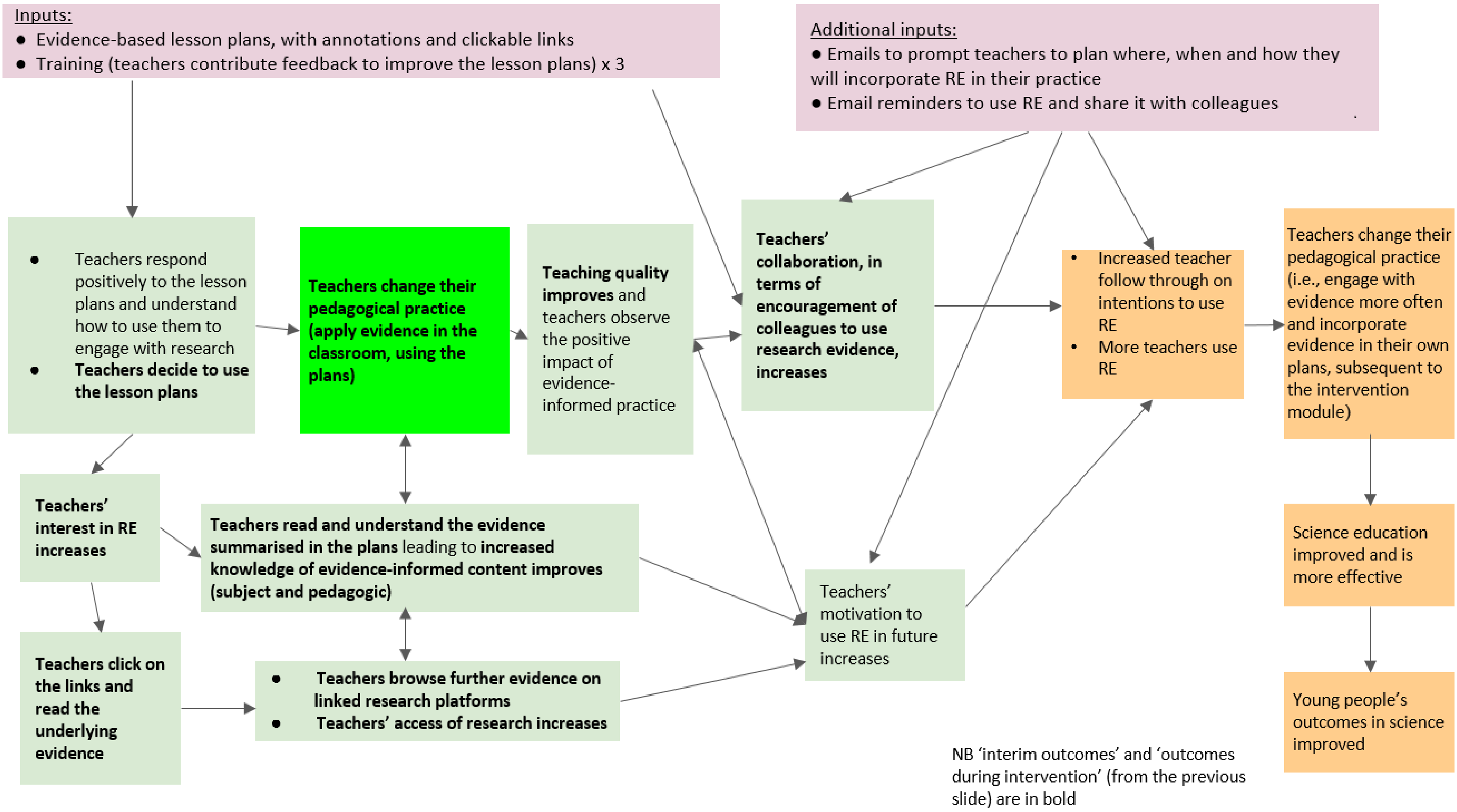
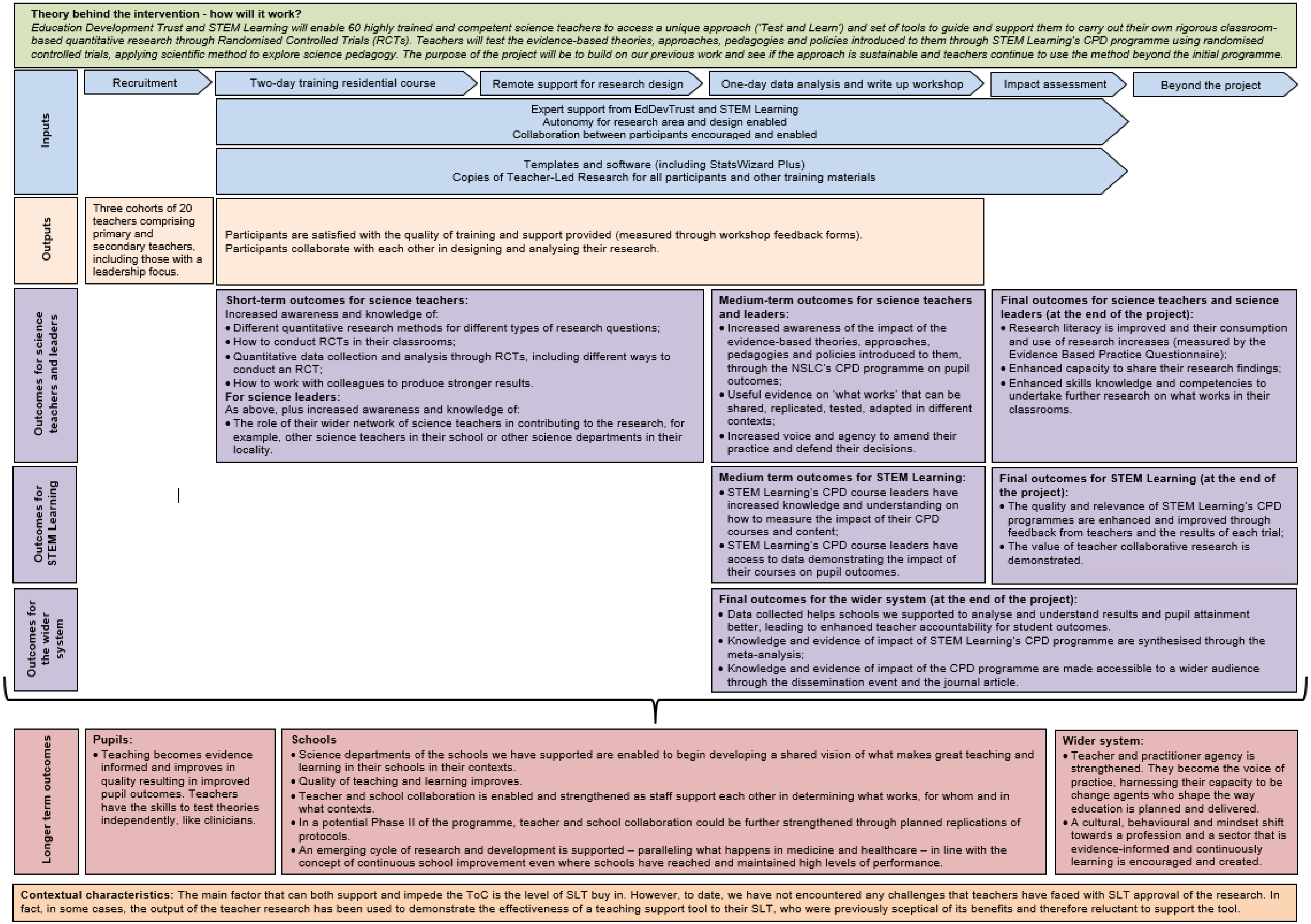


Figure 10: Teacher-led RCTs Theory of Change



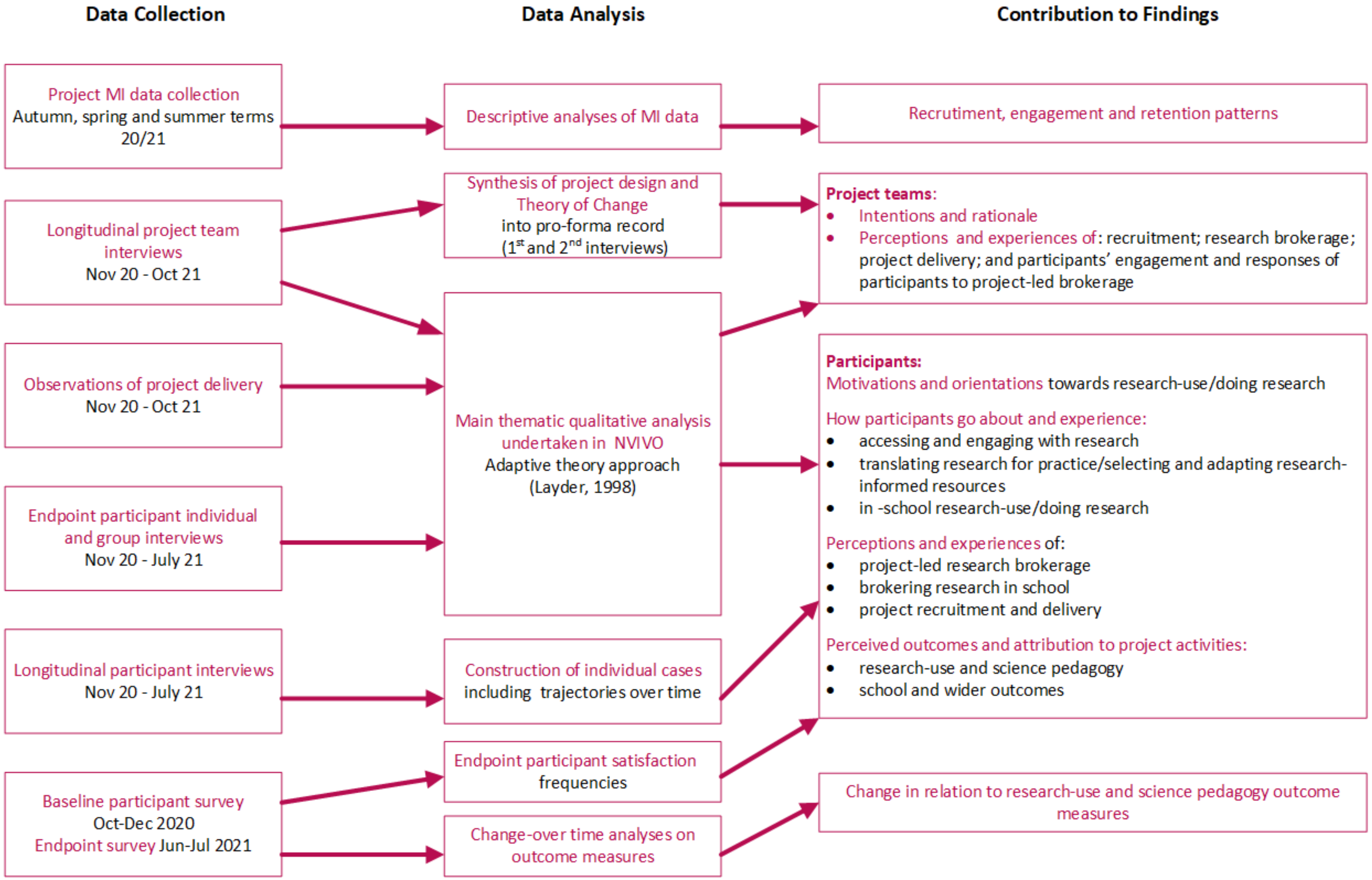
Appendix 3: Methods

A3.1 Overview

The study was undertaken in accordance with the British Education Research Association (BERA)'s ethical guidelines (BERA, 2018), and approved by Sheffield Hallam's University's Ethics Committee.

The data collection and analysis methods used in this concurrent mixed-methods study are set out in Figure 11, which also displays the data sources and how the findings of the various analyses were synthesised to draw out the findings presented in this report. Further detail on the quantitative methods are presented in Appendices 3.2 and 3.3, and the qualitative methods in Appendices 3.4 and 3.5.

Figure 11: Methods Overview



A3.2 Participant survey

Survey design

Prior to the launch of the programme, we designed a survey for administration with all programme participants at baseline (before they received any input from their respective projects) and at endpoint (after each project ended). The survey was designed so that all participants could be measured similarly in terms of common outcomes, despite differences in the individual projects' foci and approaches.

The survey comprised three sections (see Appendix 5 for more detail).

1. **Items relating to research use**. These items were an augmented version of NFER's Research Engagement Measurement Survey (Nelson et al., 2017). They focused on participants' attitudes towards, confidence in using, and actual use of research evidence.
2. **Items relating to science pedagogy**. These items were based on the seven practice recommendations in EEF's Improving Secondary Science Guidance report (Holman and Yeomans, 2018). We worked with an SIoE primary specialist to modify the question wording for primary participants. We also created question variations for the trainee teachers. All question variations were considered sufficiently similar for grouping in the analysis.
3. **Items relating to participants' views of their project**. These items related to satisfaction with the training, resources, and support provided by each project and were asked at endpoint only. There was also an additional item about participants' awareness of the EEF Improving Secondary Science Guidance report.

Section 1

Prior to developing the survey, we consulted with the four projects during a collaborative inception workshop to ensure that we fully understood their goals and discuss our proposed survey design. In developing the questions for the first part of the survey, we drew on these insights and NFER's well-tested Research Engagement Measurement Survey (Nelson et al., 2017), which was developed in consultation with a wide body of literature, and experts in the field of teachers' research engagement and knowledge mobilisation (KMb). The survey items were also developed with close reference to Nutley's research engagement constructs (cited in Nelson et al., 2017):

- **Access/awareness** (do practitioners know about research and can they find what they need)?
- **Understanding/persuasion** (do they understand what the research tells them and do the messages persuade them)?

- **Impact/use** (do they use the research to change or affirm their current practices, and what are the impacts of these changes)?

Then, within the construct of impact/use, we took account of three further domains, which describe the different ways in which practitioners apply their learning from the research (Weiss, 1979):

- **Instrumental use** (using research to make practical changes; e.g., in the classroom)
- **Conceptual use** (using research to inform thinking and discussion)
- **Strategic use** (using research as a lever for change and/or to validate existing practices).

We also drew on the extensive knowledge mobilisation and evidence brokerage literature (e.g., Becheikh et al., 2010; Campbell and Levin, 2012; Gough, 2013; Nutley, 2013; Sharples, 2013) and our own studies on research engagement and KMb, to develop a better understanding of the mechanisms by which change can be realised. This included:

- the conditions that support effective research engagement and the prevalence of teacher research engagement (SIoE's study for the DfE of teachers' research engagement (Coldwell et al, 2017)), NFER's review of evidence use in the classroom (Nelson and O'Beirne, 2014), and surveys for the EEF of teachers' research use[36]
- the conditions that support effective knowledge mobilisation/ scaling-up of evidence-based approaches (SIoE and NFER scale-up campaign evaluations for the EEF)[37]
- school conditions for evidence-informed school improvement (a study for EEF on the essential conditions for this (Walker and Nelson, 2020)).

Insights from these sources were used to modify the existing NFER Research Engagement Measurement Survey into a smaller set of questions, suitable for the science participants involved in this study.

Section 2

The EEF's Improving Secondary Science guidance report (Holman and Yeomans, 2018) contains seven recommendations on evidence-based good pedagogy for science teaching. These are as follows:

1. preconceptions – build on the ideas that pupils bring to lessons

[36] See two reports, downloadable from: https://educationendowmentfoundation.org.uk/projects-and-evaluation/evaluating-projects/eef-research-papers/

[37] See the teaching assistant and North-East literacy scale-up evaluation reports at: https://educationendowmentfoundation.org.uk/news/eef-publishes-first-scale-up-evaluations/

2. self-regulation – help pupils direct their own learning
3. modelling – use models to support understanding
4. memory – support pupils to retain and retrieve knowledge
5. practical work – use practical work purposefully and as part of a learning sequence
6. language of science – develop scientific vocabulary and support pupils to read and write about science
7. feedback – use structured feedback to move on pupils' thinking.

Each of these recommendations and their associated practice examples formed the basis of the items developed in the second part of our survey.

Each recommendation was reflected through a number of survey items. These were worded as practice statements; for example, one of the 'language of science' items was: 'I show the links between scientific words and their composite parts'. Respondents were then asked to indicate how frequently they used these strategies in the classroom to support pupils' science learning on a five-point scale: 'Never', 'Rarely', 'Sometimes', 'Often' and 'Always'. In addition to the evidence-based items, we developed a series of distractor items within each question. These distractor items were designed as examples of practice that science teachers may incorporate into their teaching, which lack an evidence base, suggesting that they are good practice for science pedagogy. These were included to assess how well the participants discriminated between the scale points when answering the questions.

In the few instances where it proved impossible to design items from the EEF guidance that were applicable to both the primary and secondary phases, we created two versions of an item – one for primary, and the other for secondary teachers. We were supported in this endeavour by SIoE's science education experts (Joelle Halliday and Professor Emily Perry). Respondents were routed to the items that were appropriate for them. These items related mainly to 'modelling' and 'practical work', where the examples typically differ across the phases. For the analysis, we considered these primary and secondary items to be equivalent, and combined them in the dataset.

Section 3

The final part of the survey contained a small number of questions that were only asked at endpoint. These questions did not form part of the outcomes analysis, but rather related to participants' specific experience and views of the projects in which they had been involved. The questions related to their satisfaction with the support received across the project as a whole, and with specific reference to: the training; resources; and broader forms of support (such as email or telephone assistance) they received.

Survey administration

The survey was delivered in an online format and participants were asked to complete it before and after the programme activity. It was administered to the participants in all four projects according to the individual start and end dates of their projects, which varied. Participants involved in the Teacher-led RCTs project were invited to complete the survey in rolling batches, because of the staggered recruitment to this project. There was also some variability in the length of time that each project's surveys remained open. This was because some of the projects had a more rapid start than others, and therefore the survey window had to be limited in order to capture a reliable baseline. Additionally, we aimed to achieve the best possible response rates across all projects, which meant that some of the surveys were held open a little longer than others, in order to maximise the response.

Despite our intention to capture a reliable baseline for all of the projects, it is important to note that, in the case of Evidence in Action and the Research-led RCTs, a small number of participants *may* have engaged with project materials prior to completing the baseline survey.

Across all of the projects, the surveys were administered between September 2020/January 2021 (the baseline) and May/July 2021 (the endpoint). Table 11 provides more details:

Table 11: Survey administration dates, by project

Project	Baseline Opened	Baseline Closed	Endpoint Opened	Endpoint Closed
Journal Clubs	Sept 2020	Oct 2020	June 2021	July 2021
Teacher-led RCTs	Sept-Dec 2020	Nov 2020-Jan 2021	July 2021	July 2021
Evidence in Action	Nov 2020	Dec 2020	May 2021	June 2021
Research-2-Practice	Nov 2020	Jan 2021	June 2021	July 2021

Survey response rates

Tables 12-14 show the number of responses obtained at baseline and endpoint as well as the number of matched baseline and endpoint surveys in which this culminated. At baseline, we achieved responses from 378 (84%) of the active[38] participants. There was, however, notable

[38] Response rates were calculated based on the number of participants who had been retained on the project at the time of the survey. COVID-19 disruption between project recruitment and the baseline survey meant that some projects had high levels of attrition prior to the start of the project delivery.

attrition in the endpoint survey response rate, as additional participants withdrew from the programme and some of the participants who had completed a baseline survey did not complete the survey again. We achieved responses from 214 (55%) of programme participants who were still active at the time of the endpoint survey. However, as shown below, not all of the endpoint respondents had completed the baseline survey – 198 (52%) of the baseline respondents also completed the endpoint survey.

Table 12: Baseline survey response rate, by project

Project	Active participants (n)	Survey responses (n)	%
Evidence in Action	101	76	75
Journal Clubs	207	180	87
Teacher-led RCTs	30	28	93
Research-2-Practice	114	94	81
Total	**452**	**378**	**84**

Table 13: Endpoint survey response rate

Project	Active participants (n)	Survey responses (n)	%
Evidence in Action	92	52	57
Journal Clubs	157	102	65
Teacher-led RCTs	28	14	50
Research-2-Practice	111	46	41
Total	**388**	**214**	**55**

Table 14: Matched baseline and endpoint response

Project	Matched responses (n)	% of baseline respondents with an endpoint survey response
Evidence in Action	46	61
Journal Clubs	95	53
Teacher-led RCTs	14	50
Research-2-Practice	43	46
Total	**198**	**52**

Although the four providers recruited participants independently, a small number of participants were recruited to multiple projects within this programme. Participants involved in multiple projects were asked to complete the survey once, but their response counted towards the number of completed responses for both projects in which they were involved. Of the three participants who were involved in multiple projects who responded to the survey, one was involved in the Evidence in Action and Journal Clubs projects, one in the Evidence in Action and Teacher-Led RCTs projects, and one in the Journal Clubs and Teacher-Led RCTs projects. Once these participants had completed the survey once, they were then sent the project-specific questions that applied to them to answer via email. For the analysis, their response was only included once. Therefore, the factors were derived using responses from the 375 unique participants who completed the baseline responses.

Tables 15-16 show the characteristics of the unique participants who responded at baseline and endpoint. Table 15 shows that at least two-thirds of these respondents were from secondary schools, and that the proportion of primary school respondents had dropped slightly by endpoint. This is consistent with the projects' design and recruitment intentions at the outset of the programme. The slight drop in the number of primary respondents is also consistent with the pattern of participant withdrawal reported in the projects' MI data (see Appendix 4 for further details).

Table 15: Survey respondents by phase

Phase	Baseline - Frequency	Baseline - %	Endpoint - Frequency	Endpoint - %
Primary	116	31	52	25
Secondary	251	67	151	72

Phase	Baseline - Frequency	Baseline - %	Endpoint - Frequency	Endpoint - %
All through	7	2	6	3
Middle	1	<1	1	<1
Missing	0	0	0	0
Total	**375**	**100**	**211**	**100**

Table 16 shows the breakdown of survey respondents by project role. All participants were practising teachers/leaders or trainee teachers, but some had a brokerage role (for example, as mentors or facilitators), while others were purely in receipt of the project interventions (identified as teachers/leaders or trainee teachers in the table). The table shows that the majority of respondents were teachers/leaders in receipt of the project interventions, with smaller proportions of mentors (from Research-2-Practice), teacher facilitators (for Journal Clubs) and trainee teachers. This pattern was consistent at baseline and endpoint, and also with the design of the projects as only two of the four sought to recruit teachers into mentor or facilitator roles and required far fewer participants in these than other project roles.

Table 16: Survey respondents by project role

Project role	Baseline Frequency	Baseline %	Endpoint Frequency	Endpoint %
Mentor	41	11	26	12
Teacher/leader	255	68	148	70
Teacher facilitator (of a Journal Club)	26	7	16	8
Trainee teacher	53	14	20	9
Missing	0	0	1	<1
Total	**375**	**100**	**211**	**100**

A3.3 Management information

During the inception workshop with the four projects, we discussed the management information (MI) data that would be required for the evaluation and how best to collect this to maximise relevance and minimise burden. We presented a suggested MI data-collection template, which we adapted collaboratively during the workshop, and subsequently agreed with the projects. The project providers were asked to complete the template at the end of each term of project delivery. We provided them with guidance on how to complete it to ensure consistent, comparable monitoring. The Evidence in Action and Journal Clubs projects were asked to do this across three terms (autumn 2020, and spring and summer 2021). The Teacher-led RCTs and Research-2-Practice projects were asked to provide this across two terms (spring and summer 2021). The providers varied in their ability to report data in an accurate, timely fashion.

The providers were asked to complete up-to-date information about their participants on the following:

- school phase
- main participant job role
- years in teaching
- main subject taught
- key stages across which taught science
- project role.

The providers also rated the extent to which each of their participants had engaged with the expected activity each term using the following scale: 'Fully', 'Partially', 'Not at all', 'Independent work only (encouraged but not monitored)', 'Participant has left the project' and 'No expected training/activity this term'. We provided advice to the project leads on how to interpret and report against these categories as part of the guidance mentioned above.

The quality of the data provided by each project varied. The Research-2-Practice project had only a limited ability to monitor the engagement of their participants as the design of the project meant that the project managers did not have any direct contact with the trainee teachers, and only had an early opportunity to make contact with their mentors. Accordingly, a very high proportion of their participants were rated as 'working independently'. This project was also unable to provide MI data about the participants who withdrew from their project. Similarly, the Teacher-led RCTs project struggled to engage with some participants in order to collect the requested MI data and so unable to provide a full dataset. Participants involved in the Research-2-Practice and Teacher-led RCTs projects could, therefore, only be included in the programme-level analyses. The limited data available about the Research-2-Practice and Teacher-Led RCTs projects meant that it was impossible to conduct project-level analyses to compare the characteristics of those retained on the project and those who formally withdrew, in either case.

At the programme level, we conducted a descriptive analysis to understand the composition of the final sample of participants recruited to the programme at the beginning of the year. We investigated the composition by phase, job role, years in teaching and main subject taught. We also ran a descriptive analysis of the engagement ratings for each term, including crosstabulations, to see if any patterns emerged by phase and job role. It was not possible to complete crosstabulations by years in teaching or project role as participant numbers were too small. In addition to these descriptive analyses, we calculated the proportion of participants who maintained high levels of engagement and those who persistently failed to engage. A high level of engagement was defined as being rated 'fully' engaged for a minimum of two terms, whereas a low level of engagement was defined as being rated 'not at all' engaged for a minimum of two terms.[39]

At the project level, we conducted descriptive analyses to compare the characteristics of the participants who withdrew from the Evidence in Action and Journal Clubs projects compared to those who were retained on those projects. The following characteristics were compared for withdrawn and retained participants: phase, participant job role, years in teaching, main subject taught, and project role (for the Journal Clubs project only).

A3.4 Qualitative data generation

Qualitative methods were used to gather data from the participants and project teams to: deepen understanding of how science teachers use and/or carry out research and the project approaches that broker this, and offer explanations of the observed quantitative outcomes. Generic research instruments, designed using the conceptual tools, outlined in the main report (Section 1.4), were tailored for use in each project. The following methods were deployed across all projects; however, the number and timing of the data collection activities were tailored in relation to the number of project participants, the nature of the project, and the project timeline:

Online observations of project activity

In total, 12 observations were undertaken and recorded using a semi-structured pro-forma. The observations spanned the training sessions/workshops for participants across the projects, Journal Clubs meetings, and, for the Teacher-led RCT project, the end of project conference. These observations captured data on how research use/carrying out research was brokered by the projects, and participants' responses to the brokering activity.

As the initial training for the Journal Clubs participants was provided via online self-study modules, two observations (for the teacher facilitators and teacher participants, respectively) were undertaken by the observer working independently through the online modules.

[39] The terms in which participants were rated 'fully' or 'not at all' engaged could be non-consequetive.

Longitudinal semi-structured online or telephone interviews with project teams

In total, 16 group or individual interviews were conducted with the project leaders as well as other team members involved in translating research to inform practice or project delivery (Table 17), involving 19 unique participants. Interviews were carried out at two or three time points, depending on the length of the project. Data were gathered on:

- project's aims and theories of change
- project's approaches to brokering research use/doing research and perceptions of participants' responses to project activity
- perceptions and experiences of the project's recruitment, delivery, and outcomes
- reflections on the challenges of brokering research use/doing research, including responding to the COVID-19 pandemic, and how these were addressed
- future plans for project development.

Table 17: Longitudinal project team interviews by project and timing

Project	Beginning	Midpoint	Endpoint
Journal Clubs	1	1	1
Research-2-Practice	1	6	1
Evidence in Action	1	0	1
Teacher-led RCTs	1	2	1
Total	**4**	**8**	**4**

Longitudinal semi-structured online or telephone interviews with project participants

The intention in the Journal Clubs, Evidence in Action and Teacher-led RCT projects was to interview three teacher participants, identified through variation sampling, at the beginning, midpoint, and end of the project. The intention in the Research-2-Practice project was to collect similar data from four mentors and four trainee teachers. These longitudinal interviews aimed to explore participant trajectories in terms of:

- orientation towards, and confidence in, research use/doing research
- research use/doing research
- any changes in their pedagogical practices that the interviewees attributed to their project participation – this involved capturing detailed accounts of teaching specific lessons and/or curriculum development

- perceptions and experiences of project-led research brokerage - and whether, and if so how, this impacted their trajectory
- any experiences of brokering research within their own school and the related outcomes of this
- how their school context enabled or impeded research use/doing research.

Attrition from the projects and inability to commit time to attend interviews, due to the demands of the COVID-19 pandemic, meant that not all the intended interviews took place. In total, 36 interviews were conducted (Table 18).

Table 18: Longitudinal participant interviews by project, participant type, and timing

Project and participant	Beginning	Midpoint	Endpoint
Journal Clubs teachers	3	3*	0
Research-2-Practice mentors	4	0	3
Research-2-Practice trainee teachers	4	3	3
Evidence in Action teachers	3	3	3
Teacher-led RCTs teachers	3	1*	0
Total	**17**	**10**	**9**

*These interviews were conducted midway between the midpoint and endpoint

Online endpoint semi-structured group or one-to-one interviews with participants

Data were generated from 80 participants in total, across 31 individual and 13 group interviews, held immediately after or close to the end of their project (Table 19).[40] Data were gathered on:

- the perceptions and experiences of project recruitment, project-led research brokerage, and any outcomes that were attributed to the project-led research brokerage
- any experiences of brokering research within their own school and outcomes of this
- how their school context enabled or impeded their research use/doing research.

Fewer participants were recruited for the endpoint interviews and group interviews than hoped, and many participants did not respond to the requests. To increase the number of participant

[40] All interviews were completed by the end of July 2021. The Teacher-led RCT project ran until October 2021, so the participants in this project were interviewed while the project before the poject end..

perspectives in the analysis, participants who declined to be interviewed were asked if they would like to provide email feedback on their project experiences or, if appropriate, why they had not fully engaged with or dropped out of the project. In total, 21 email responses were received, that were subsequently incorporated into the qualitative dataset.

Table 19: Endpoint participant interviews by project, participant type, and interview type

Project and participant	Individual interviews	Group interviews
Journal Clubs teachers	6	7
Journal Clubs facilitators	1	1
Research-2-Practice mentors	5	2
Research-2-Practice trainee teachers	5	0
Evidence in Action teachers	8	2
Teacher-led RCTs teachers	6	1
Total	**31**	**13**

All interviews were recorded with participants' permission and transcribed for analysis

A3.5 Qualitative data analysis

Analysis was undertaken using an adaptive theory approach (Layder, 1998):

> *the word 'adaptive' is meant to convey that the theory both adapts to, or is shaped by, incoming evidence while the data itself is simultaneously filtered through, and is thus adapted by, the prior theoretical materials (p5).*

We drew on the existing theory to shape the design of this study (see Section 1.3) and develop conceptual tools (Section 1.4). These concepts and theories were used to create an analytical frame for the qualitative data, so that the data were filtered through existing theory. Thematic deductive and inductive approaches were used to 'adapt' and build on, the existing theory.

The first stage of the analysis was to organise and reduce the amount of data. Templates were produced for each project based on the longitudinal project team interviews to create detailed project descriptions, covering: the project's aims; structure; activities; timeline; resources for participants; the nature of any ongoing support; theory of change, including the design rationale; and changes that occurred to all of these factors over the duration of the project. The main analysis, which included data from the observations, and longitudinal project team interview and endpoint participant interview transcripts, was undertaken using NVivo qualitative data analysis software. A node structure was created from the analytical framework. The research team coded a small number of transcripts from each project and completed several iterations of node[41] re-structuring to create a final structure of nodes and sub-nodes (Box 9). All data were then coded to this node structure. Early-stage coding review meetings were undertaken to ensure consistency of the coding decisions. Coding was followed by a thematic analysis within each node and an exploration of the patterns within and between nodes. Key themes are reported in Chapters 2-5.

Box 9: Main qualitative analysis - top-level codes

Context - a) schools' use of research; b) other relevant school contextual characteristics; c) participants' prior knowledge and experience of using/doing research

Motivations for joining the project

Recruitment - a) project team recruitment strategies; b) participants' experiences of recruitment

Engagement and retention - a) factors attributed to continued engagement; b) reasons for not fully participating in or withdrawing from the programme

Using and doing research - a) accessing and engaging; b) translating research to inform practice; c) selecting and adapting research-informed resources; d) in-school use of research and/or research-informed resources; e) doing research (Teacher-led RCT project only) - influences on the choice of pedagogical 'intervention' to trial and the trial design/use of pedagogical research to design the intervention/experience of trial implementation/experience of analysing trial data; f) other

Perceptions of programme quality and relevance - a) content of the training; b) delivery methods; c) resources; d) skills, experiences, quality of deliverers; e) communication; f) ongoing support as part of the delivery; g) support from Journal Clubs facilitators and Research to Practice mentors; h) other

Perceived outcomes - a) participants and their practices; b) pupils; c) wider school outcomes; d) cross schools and networks; e) features of the project that the participants attributed to positive outcomes

[41] In NVivo a node is a collection of references (in this case, participant statements) about a specific theme; e.g., 'training'.

Enablers of and barriers to research use – a) project-related factors; b) school factors; c) personal; d) the impact of COVID-19

Future plans - a) project teams; b) participants

Project teams - learning about brokering research use/doing research

Exploratory Concepts[42] - a) professional identity; b) agency; c) collaboration; d) reflection

A trajectory summary template was completed for each longitudinal participant interviewee, that synthesized data from each of their interviews. The template recorded:

- participant characteristics: for example, subject, subject leadership responsibility, years in teaching)
- school characteristics: for example, phase, type, Key Stage 2 and 4 pupil attainment, percentage of pupils in receipt of free school meals; the orientation of the school, and the participant's department or team, towards research; and the extent to which a research-informed learning culture was evident - including the autonomy teachers had to experiment with their practices
- the nature and extent of participants' engagement in their project
- participant trajectories, comprising detailed accounts over the period of their project, any changes, and how and why these occurred, in relation to:
    - science teaching practices (planning, teaching and curriculum development) and science teacher identity
    - orientation towards and confidence in, using research/doing research
- research use: accessing and engaging; translating to inform practice, selection and adaptation of research-informed resources; in-school research use and carrying out research; fidelity to the research
- perceived outcomes of project participation
- extent, purposes and outcomes of collaboration - with colleagues on the course, in school and/or in wider networks - in relation to research use and developing science practices and curricula
- the inter-relationships between project activity, their personal characteristics and motivation, and their school context (including the effects of the COVID-19 pandemic) that they perceived as having impacted on their research use and science practice trajectories.

A team analysis meeting was held to identify the key themes emerging from the syntheses. This identified a close match between the themes emerging from the syntheses and the main qualitative analysis. Due to the variation across the projects in terms of securing the longitudinal interviews, and the limited extent to which some of the participants had been able to implement learning from their project, a cross-case analysis was not undertaken. Illustrative examples and vignettes were drawn from the synthesis to supplement the illustrations arising from the main qualitative analysis and provide potential explanations for some of the outcome findings.

Appendix 4: MI Analyses

This appendix contains full data tables produced through the MI analysis. Tables 20-22 show the descriptive analyses of the recruited participant MI data at the programme level, based on a range of characteristics.

Table 20: Programme participants by phase

Phase	Percentage
Primary	30%
Secondary	68%
Other	2%

Table 21: Programme participants by main subject taught

Main subject taught	Percentage
General science	34%
Biology	24%
Chemistry	18%
Physics	15%
Missing	9%

Table 22: Programme participants' characteristics

Job role	Percentage
Classroom teacher	35%
Science subject leader	28%
Trainee teacher/NQT	21%
Middle/senior leader	15%
Missing	1%

*Due to rounding, the percentages may not sum to 100.

Tables 23-28 show the engagement levels of participants at the project level and by a range of key characteristics.

Table 23: Autumn term participant engagement levels by project[43]

Engagement level	Evidence in Action – Number of participants	Evidence in Action - %	Journal Clubs – Number of participants	Journal Clubs - %
Fully	86	78	96	46
Partially	1	1	53	26
Not at all	21	19	22	11
Independent work only	0	0	0	0
Participant has left the programme	2	2	36	17
Total	**110**	**100**	**207**	**100**

Due to rounding, the percentages may not sum to 100%

[43] Evidence in Action and Journal Clubs were the only projects to deliver training or project activity during the autumn term and so the only projects able to provide data for the autumn term.

Table 24: Spring term engagement levels by project

Engagement level	Evidence in Action – Number of participants	Evidence in Action - %	Journal Clubs - Number of participants	Journal Clubs - %	Teacher-led RCTs - Number of participants	Teacher-led RCTs - %	Research-2-Practice - Number of participants	Research-2-Practice - %
Fully	38	35	71	34	15	39	18	16
Partially	35	32	52	25	9	24	0	0
Not at all	16	15	40	19	4	11	0	0
Independent work only	7	6	0	0	0	0	96	83
Participant has left the programme	14	13	44	21	10	26	2	2
Total	**110**	**101**	**207**	**99**	**38**	**100**	**116**	**101**

Due to rounding, the percentages may not sum to 100%

Table 25: Summer term engagement levels by project

Engagement level	Evidence in Action - Number of participants	Evidence in Action - %	Journal Clubs - Number of participants	Journal Clubs - %	Teacher-led RCTs - Number of participants	Teacher-led RCTs - %	Research-2-Practice - Number of participants	Research-2-Practice - %
Fully	50	45	28	13	14	37	0	0
Partially	1	1	91	44	10	26	0	0
Not at all	17	15	42	20	4	11	0	0
Independent work only	24	22	0	0	0	0	102	88
Participant has left the programme	18	16	47	23	10	26	14	12
Total	**110**	**99**	**208**	**100**	**38**	**100**	**116**	**100**

Due to rounding, the percentages may not sum to 100%

Table 26: Autumn term participant engagement levels by phase[44]

Engagement level	Primary - Number of participants	Primary - %	Secondary - Number of participants	Secondary - %	Other - Number of participants	Other - %
Fully	17	29	156	63	7	88
Partially	17	29	37	15	0	0
Not at all	9	16	34	14	0	0
Independent work only	0	0	0	0	0	0
Participant has left the programme	15	26	21	9	1	13
Total	**58**	**100**	**248**	**101**	**8**	**101**

Due to rounding, the percentages may not sum to 100%

[44] Excluding duplicate participants

Table 27: Spring term participant engagement levels by phase[45]

Engagement level	Primary - Number of participants	Primary - %	Secondary - Number of participants	Secondary - %	Other - Number of participants	Other - %
Fully	32	23	104	33	5	63
Partially	13	9	79	25	2	25
Not at all	13	9	47	15	0	0
Independent work only	60	42	43	14	0	0
Participant has left the programme	24	17	44	14	1	13
Total	**142**	**100**	**317**	**101**	**8**	**101**

Due to rounding, the percentages may not sum to 100%

[45] Excluding duplicate participants

Table 28: Summer term participant engagement levels by phase[46]

Engagement level	Primary – Number of participants	Primary - %	Secondary – Number of participants	Secondary - %	Other – Number of participants	Other - %
Fully	8	6	74	23	7	88
Partially	24	17	78	25	0	0
Not at all	13	9	50	16	0	0
Independent work only	62	44	64	20	0	0
Participant has left the programme	35	25	52	16	1	13
Total	**142**	**101**	**318**	**100**	**8**	**101**

Due to rounding, the percentages may not sum to 100%

[46] Excluding duplicate participants

Tables 29-32 show the descriptive analyses of the participants retained and withdrawn from the Evidence in Action and Journal Clubs.

Table 29: Evidence in action retained and withdrawn participants by phase

Phase	Retained participants - Number of participants	Retained participants - %	Withdrawn participants - Number of participants	Withdrawn participants - %
Primary	N/A	N/A	N/A	N/A
Secondary	85	92	17	94
Other	7	8	1	6
Total	**92**	**100**	**18**	**100**

Due to rounding, the percentages may not sum to 100%

Table 30: Evidence in action retained and withdrawn participants by role

Role	Retained participants - Number of participants	Retained participants - %	Withdrawn participants - Number of participants	Withdrawn participants - %
Trainee teacher	3	3	0	0
NQT	4	4	2	11
Classroom teacher	45	49	13	72
Middle leader	5	5	0	0
Science subject leader	32	35	2	11
Senior leader	3	3	1	6
Total	**92**	**99**	**18**	**100**

Due to rounding, the percentages may not sum to 100%

Table 31: Journal Clubs retained and withdrawn participants by phase

Phase	Retained participants - Number of participants	Retained participants - %	Withdrawn participants - Number of participants	Withdrawn participants - %
Primary	39	24	20	43
Secondary	122	76	27	57
Other	0	0	0	0
Total	**161**	**100**	**47**	**100**

Due to rounding, the percentages may not sum to 100%

Table 32: Journal Clubs retained and withdrawn participants by role

Role	Retained participants - Number of participants	Retained participants - %	Withdrawn participants - Number of participants	Withdrawn participants - %
Trainee teacher	12	8	6	14
NQT	6	4	2	5
Classroom teacher	42	26	7	16
Middle leader	27	17	2	5
Science subject leader	61	38	21	48
Senior leader	12	8	6	14
Total	**160**	**101**	**44**	**102**

Due to rounding, the percentages may not sum to 100%

Appendix 5: Research use and science pedagogy factors

A5.1 Factor derivation

This appendix describes how we derived the factors that were used as outcome measures. We started by running an exploratory factor analysis (EFA) that included all of the baseline survey items and distractor items associated with a domain: research use (RU) or science pedagogy (SP), in order to identify its underlying factor structure. The initial EFA was run for the same group of respondents, and only respondents with no missing responses for all survey items were included in the analyses.

Two hundred and fifty-six cases (68% of the total),[47] had no missing values at baseline and could be included in the initial EFA.

The first step was to determine how many factors were associated with each domain. For this, we calculated the eigenvalues associated with the domain's correlation matrix and drew the corresponding scree plot.[48] There are three methods that can be applied to determine how many factors should be considered:

1. retain the factors associated to eigenvalues that are greater than one
2. the 'elbow' rule: a sharp break and change of curvature (elbow) in the scree plot suggest the number of factors to extract
3. parallel analysis as per (Horn, 1965), where the scree of the factors in the observed data is compared with that of a random data matrix of the same size as the original.

The results of the parallel analyses and scree plots are displayed in Figures 12 and 13 below. The 'simulated data' line in these plots refers to random normal deviations from the original data matrix and the 'resampled data' line is based on resampling of the original data. In this case, the two are virtually identical, which is why it is not possible to distinguish them visually. The parallel analysis and 'elbow' suggest that the underlying factor structure for the RU domain contains between four and six factors, and for the SP domain between five and eight.

[47] By provider: 64% (47 out of 74) in BIT, 73% (129 out of 179) in CCT, 79% (22 out of 28) in EDT, and 62% (58 out of 94) in RH, excluding duplicate responses from the participants involved in more than one project.

[48] A scree plot shows the eigenvalues on the y-axis and the number of factors on the x-axis.

Figure 12: Parallel analysis and scree plots for the RU domain

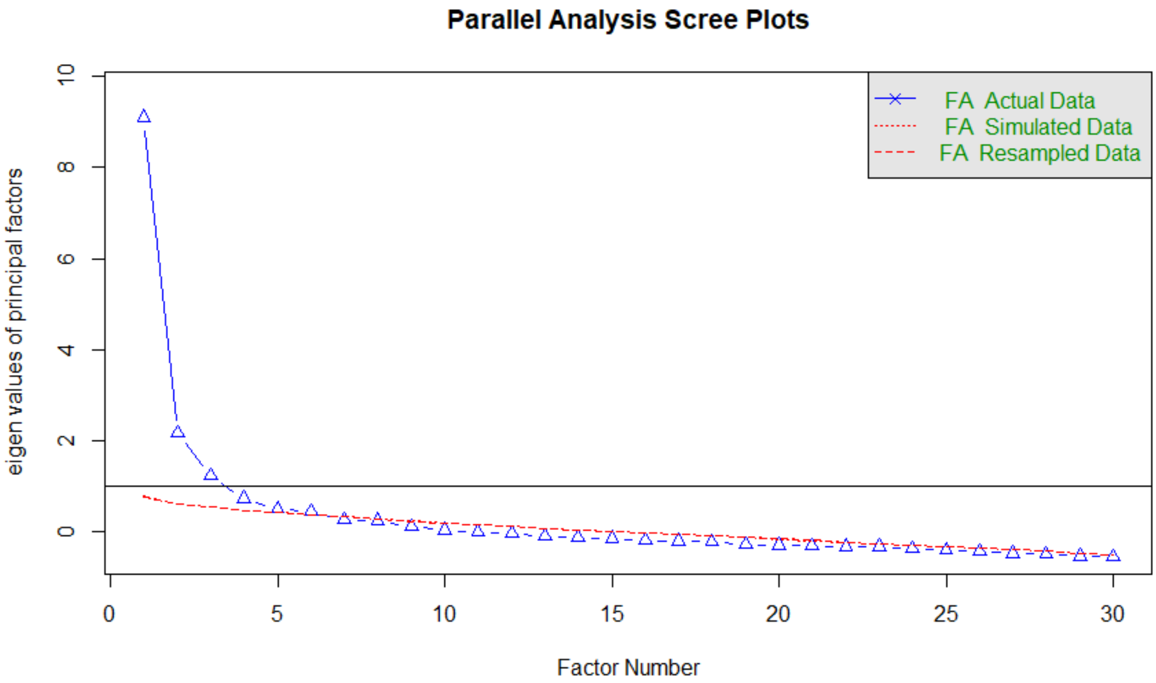
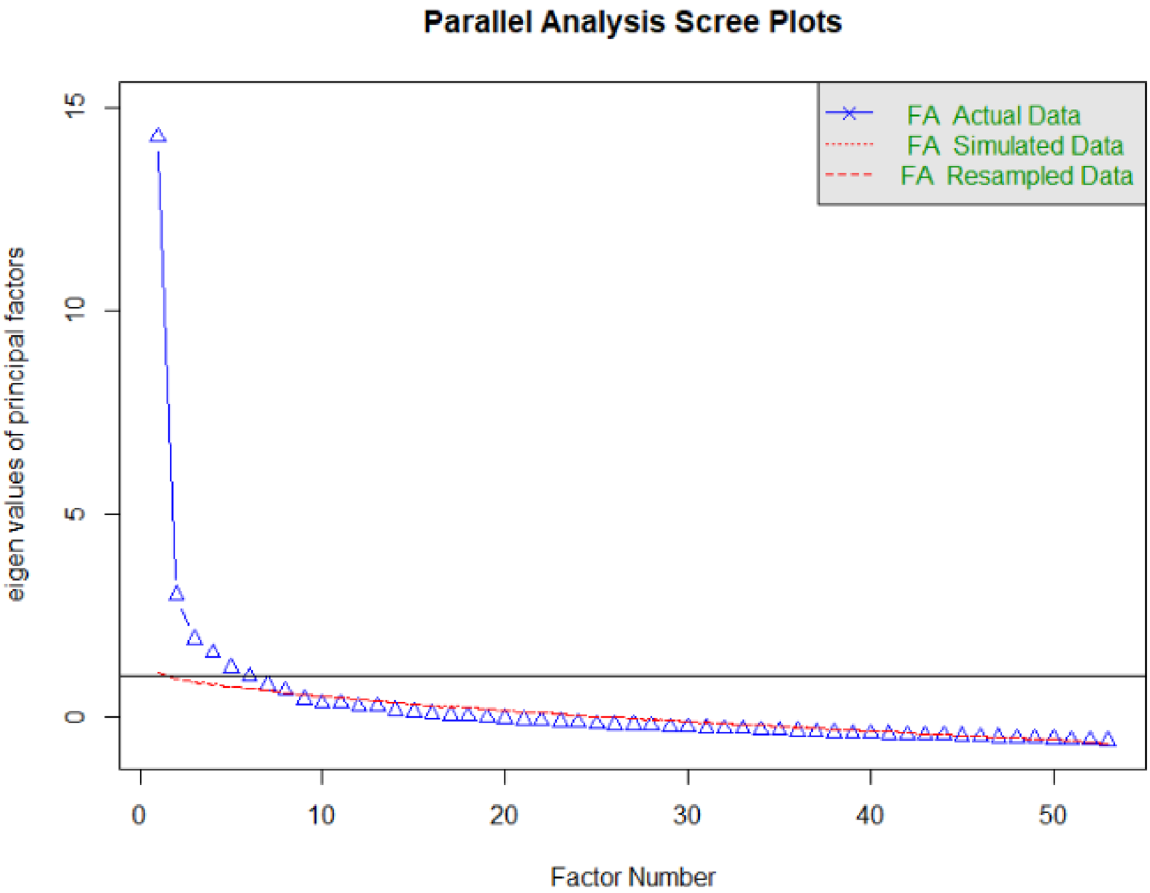


Figure 13: Parallel analysis and scree plots for the SP Domain



For each domain, we ran several EFAs, considering both varimax and oblimin rotation and the number of factors suggested by the parallel analyses and 'elbow' rule. Both the varimax (Kaiser, 1958) and oblimin (Jackson, 2005) rotation tend to align items to a single factor with very small loads on the remaining ones, which makes it easier to interpret the derived structure. The factor structures were defined by associating items to factors in which they loaded higher than 0.3 according to three different strategies:

1. associating to each factor all the items that loaded above 0.3
2. associating each item to the factor where the load is the maximum (and above 0.3)
3. removing from the model the items that loaded above 0.3 in more than one factor.

After trying and testing several factor models, we selected a five factor model with oblimin rotation, described in table 33 below, as the most suitable for the RU domain, and a seven factor model with oblimin rotation, described in table 34 below, for the SP domain.

Table 33: Item-factor alignment and standardised loadings for the RU domain[49]

Standardized loadings (pattern matrix) based upon correlation matrix

	item	MR2	MR1	MR3	MR4	MR5	h2	u2	com
RE_Q5_5	21	0.83					0.706	0.29	1.1
RE_Q5_4	20	0.79					0.562	0.44	1.1
RE_Q5_7	23	0.74					0.712	0.29	1.2
RE_Q5_6	22	0.73					0.716	0.28	1.1
RE_Q5_8	24	0.72					0.553	0.45	1.2
RE_Q5_2	19	0.67					0.469	0.53	1.2
RE_Q5_9	25	0.61					0.543	0.46	1.3
RE_Q4_11	16		0.86				0.801	0.20	1.0
RE_Q4_5	11		0.80				0.661	0.34	1.0
RE_Q4_8	13		0.72				0.667	0.33	1.1
RE_Q4_10	15		0.64				0.391	0.61	1.0
RE_Q4_6	12		0.60				0.543	0.46	1.4
RE_Q4_12	17		0.51				0.255	0.75	1.6
RE_Q4_1	8		0.50				0.564	0.44	1.7
RE_Q4_9	14		0.45				0.394	0.61	1.5
RE_Q3_6	4			0.69			0.492	0.51	1.2
RE_Q3_5	3			0.65			0.472	0.53	1.1
RE_Q3_9	7			0.64		0.31	0.566	0.43	1.5
RE_Q3_8	6			0.59			0.505	0.50	1.3
RE_Q4_2	9				0.85		0.788	0.21	1.0
RE_Q5_1	18				0.57		0.596	0.40	1.5
RE_Q4_3	10				0.43		0.596	0.40	2.3
RE_Q3_2_Dist	2					0.51	0.306	0.69	1.5
RE_Q3_1_Dist	1					0.50	0.269	0.73	1.4
RE_Q3_7_Dist	5						0.088	0.91	1.8

[49]See tables 38-41 for the labels and factor loading scores for these items. At the time of analysis, the term research engagement (RE) was being used as a label for what we now call research use (RU). [50]See tables 43-48 for the labels and factor loadings for these items.

Table 34: Item-factor alignment and standardised loadings for the SP domain[50]

Standardized loadings (pattern matrix) based upon correlation matrix

	item	MR2	MR1	MR6	MR3	MR7	MR5	MR4	h2	u2	com
SP_Q6_12	11	0.76							0.60	0.40	1.1
SP_Q6_15	13	0.65							0.60	0.40	1.4
SP_Q6_14	12	0.63							0.56	0.44	1.4
SP_Q6_5	4	0.54							0.52	0.48	1.7
SP_Q6_4	3	0.53							0.44	0.56	1.6
SP_Q6_2	1	0.51							0.29	0.71	1.5
SP_Q6_9	8	0.50							0.41	0.59	1.5
SP_Q6_11	10	0.46							0.42	0.58	2.2
SP_Q6_8_Dist	7	0.40							0.39	0.61	2.6
SP_Q7_9	21	0.34							0.37	0.63	2.8
SP_Q6_7	6	0.33							0.33	0.67	2.9
SP_Q9_5	31		0.83						0.66	0.34	1.0
SP_Q9_7_Dist	33		0.78						0.61	0.39	1.1
SP_Q9_6	32		0.76						0.71	0.29	1.1
SP_Q9_8	34		0.50						0.46	0.54	1.9
SP_Q9_10	36		0.48						0.54	0.46	1.9
SP_Q9_9	35		0.46						0.57	0.43	2.1
SP_Q9_11_Dist	37		0.44						0.50	0.50	2.3
SP_Q9_3	29			0.83					0.67	0.33	1.1
SP_Q9_4	30			0.80					0.67	0.33	1.1
SP_Q9_1	27			0.75					0.68	0.32	1.1
SP_Q9_2_Dist	28			0.62					0.60	0.40	1.4
SP_Q10_6	41			0.38					0.42	0.58	3.1
SP_Q7_2	15				0.66				0.48	0.52	1.3
SP_Q7_4	16				0.65				0.63	0.37	1.4
SP_Q7_5	17				0.64				0.60	0.40	1.3
SP_Q7_6	18				0.59				0.50	0.50	1.6
SP_Q7_1	14				0.55				0.33	0.67	1.6
SP_Q7_8	20				0.47				0.47	0.53	1.7
SP_Q6_3	2				0.33				0.44	0.56	4.8
SP_Q7_7_Dist	19				0.31				0.36	0.64	3.1
SP_Q8_4	23					0.62			0.43	0.57	1.2
SP_Q8_5	24					0.62			0.46	0.54	1.2
SP_Q8_9	26					0.53			0.36	0.64	1.2
SP_Q8_6	25					0.52			0.43	0.57	1.9
SP_Q8_1	22					0.50			0.51	0.49	1.9
SP_Q10_2	39						0.68		0.60	0.40	1.1
SP_Q10_1_Dist	38						0.57		0.50	0.50	1.3
SP_Q10_8	42						0.50		0.59	0.41	2.0
SP_Q10_4.5	40							0.58	0.47	0.53	1.3
SP_Q10_9_Dist	43							0.42	0.45	0.55	2.5
SP_Q6_10	9				0.33			-0.38	0.52	0.48	3.3
SP_Q6_6	5				0.32			-0.33	0.51	0.49	4.4

As per the protocol, the distractor items were pulled out of the structures defined in the EFA, and confirmatory factor analyses (CFA) were performed in order to determine if the factor structures were still viable. The following minimal criteria for goodness of fit (Gatignon. 2010) were adopted for the CFA:

1. Cronbach's alpha above 0.7

[50]See tables 43-48 for the labels and factor loadings for these items.

2. standardised factor loadings above 0.6
3. CFI (comparative fit index) and TLI (Tucker-Lewis Index) above 0.9
4. RMSEA (root mean square error of approximation) and SRMR (standardized root mean square) below 0.08.

Unfortunately, only very strict, restrictive models, that incorporated only a small proportion of the items initially associated with each domain, met all of the goodness of fit criteria, so we decided to relax the conditions on the structures to just meet the reliability criterion specified in the protocol, a Cronbach's alpha above 0.7, and that the standardized factor loadings of the items associated with a given factor exceeded 0.6.

Whenever an item in a CFA had a standardized loading inferior to 0.6, the item was excluded from the model that was then refitted using the remaining items. After exploring several alternative models, the team settled for the factor structures described in Tables 37-48, as these led to structures that were easier to understand and conceptualise in qualitative terms. The factor scores at baseline and endpoint were derived using regression, one of the options of the lavaan package (Rosseel, 2012).

A5.2 Sensitivity Analysis

We could only collect endpoint data for 52% of the respondents who answered the baseline survey. This extent of missingness affects the quality of the analyses in two ways: on the one hand, there is a loss of power to detect small effects while, on the other, if there is an underlying pattern associated with missingness, the analysis results may be biased. We decided to perform a missing data analysis to explore to what degree the change-over-time analysis we performed was affected by bias.

To investigate the existence of a pattern to missingness, we fitted a logistic regression model with presence at endpoint survey as the dependent variable, and the following as covariates: provider of a training programme; the respondent's role in the school; and stage of the pupils that the respondent was teaching. As shown in Table 35 below, the respondent's role in the school was found to be a significant predictor of presence in the endpoint survey, with trainee teachers being less than half as likely to be included in the change-over-time analysis as classroom teachers (baseline category).

After evaluating the presence of a missingness pattern in the analysis data sets, we proceeded to run sensitivity analyses, comparing the results of the paired t-tests described in Appendix 6 with the corresponding t-tests performed on multiple imputed datasets.

We input the missing factor scores at endpoint using predictive mean matching, with five plausible values derived for each case. These imputations were performed using the provider, role, and stage variables described above via the mice procedure contained in the R package mice (Van Buuren and Groothuis-Oudshoorn, 2011). The paired t-tests were performed on the multiple imputed data sets and the results aggregated using the function mi.t.test contained in the R package MKmisc (Kohl, 2021). The function mi.t.test builds on the methods described in (Rubin, 1987) and (Barnard and Rubin, 1999).

The results of the sensitivity analyses are displayed in Table 35, below. Only for RE Factor 1, RE Factor 4, and SP Factor 5 did the t-tests performed on multiple imputed data sets allow for the rejection of the null hypothesis that the mean factor scores are equal at baseline and endpoint, in line with the results of the original analyses. However, in these cases, the absolute errors are small (<0.1), which suggests a reasonable agreement exists between the results of the original analyses and those of the analyses performed on imputed data sets. Some subgroups within the baseline sample were significantly more likely to be absent at midpoint but the change-over-time analyses do not seem to have been substantially affected by biases.

Table 35: Logistic regression model for respondent participation in the endpoint survey

Predictor Categories	Raw coefficient	Standard error	Odds ratio	p-value
Project - Evidence in Action (baseline)	-	-	-	-
Project- Journal Clubs	-0.196	0.295	0.822	0.506
Project - Teacher-led RCTs	-0.345	0.457	0.708	0.450
Project - Research-2-Practice	0.135	0.409	1.144	0.742
Role - Classroom teacher (baseline)	-	-	-	-
Role - Middle Leader	0.218	0.250	1.243	0.383
Role - Senior Leader	-0.551	0.416	0.576	0.186
Role - Trainee teacher	-0.900	0.413	0.407	0.029*

Predictor Categories	Raw coefficient	Standard error	Odds ratio	p-value
Stage - Secondary	-	-	-	-
Stage - Primary	-0.303	0.275	0.738	0.270
Stage - Other**	-0.905	0.531	0.405	0.089

*Statistically significant at a level of 0.05

**Respondents who identified their stage as other than ‘primary’ or ‘secondary’ were grouped together in the regression as ‘other’ due to the smaller numbers in each category preventing reliable estimation.

Table 36: Comparison of results of paired t-tests performed in the analysis data set versus those performed in the five imputed datasets

Factor	Analysis - data set Difference in means	Analysis data set - p-value	Imputed data sets - Difference in means	Imputed data sets - p-value	Absolute error
RU Factor 1	-0.333	<0.001*	-0.304	0.219	0.029
RU Factor 2	-0.332	<0.001*	-0.301	0.014*	0.031
RU Factor 3	-0.314	<0.001*	-0.311	0.065	0.003
RU Factor 4	-0.183	<0.001*	-0.198	0.015*	0.015
SP Factor 5	-0.147	<0.001*	-0.058	0.773	0.089
SP Factor 6	-0.090	0.003*	-0.093	0.419	0.003
SP Factor 7	-0.185	<0.001*	-0.196	0.181	0.011
SP Factor 8	-0.079	<0.001*	-0.052	0.527	0.027
SP Factor 9	-0.075	0.020*	-0.138	0.041*	0.063
SP Factor 10	-0.116	<0.001*	-0.059	0.55	0.057

* Statistically significant at the level of 0.05

A5.3 Outcome measures

The processes described above resulted in the following ten factors, which we use as outcome measures in our analysis and reporting.

The teacher:

Research use (RU) factors:

1. is confident in accessing research evidence
2. is confident in assessing the quality of research evidence
3. is confident using and applying research evidence
4. actively uses research evidence in practice.

Science pedagogy (SP) factors:

1. supports pupils to challenge misconceptions and review their learning
2. uses practical work purposefully
3. uses models to support understanding
4. uses practices that support the retention and retrieval of knowledge
5. helps pupils to develop scientific vocabulary
6. supports pupils to direct their own learning.

These factors effectively covered most of the intended RU constructs and six of the seven EEF recommendations. They did not, however, include any of the items related to EEF recommendation 7 - ‘using structured feedback’. Similarly, items exploring RU ‘collaboration’ did not scale well or load onto a common factor. We were keen to see how participants’ views changed in relation to these topics - therefore, we decided to include relevant single items in the change-over-time analysis, alongside the final RU and SP factors.

To conduct this analysis, we ran a t-test to compare the baseline factors (or items) to the corresponding endpoint factors (or items). This tested the statistical significance of the change observed in the score for each factor or item between baseline and endpoint. Significant changes were observed across all ten factors and across four of the eight individual items tested. Chapter 4 and Appendix 6 show the full results tables from this change-over-time analysis.

To support this analysis, we also ran a series of descriptive analyses (including crosstabulations) on items related to the Teacher-led-RCT’s participants’ confidence in carrying out research, and participant satisfaction questions for all projects. Appendix 6 contains the full results tables for this descriptive analysis.

Research use (RU) factor scores and loadings

The table below shows the Cronbach's alpha scores for each of research engagement and use factors.

Table 37: Cronbach's alpha scores for each of research engagement and use factors

Factor	Alpha score
Factor 1 - Teacher is confident in accessing research evidence	0.80
Factor 2 - Teacher is confident in assessing the quality of research evidence	0.81
Factor 3 - Teacher is confident in using and applying research evidence	0.90
Factor 4 - Teacher actively use research evidence in practice	0.87

The following tables show the individual survey question items that constituted each of the RU factors following the factor analysis.

Table 38: Survey items that load on to factor 1 – teacher is confident in accessing research evidence

Factor 1 - teacher is confident in accessing research evidence	Loading	Item code
I know where to find research that may help to inform my science teaching	0.766	RE_Q4_2
I am confident locating research information that is relevant to science teaching	0.869	RE_Q5_1

Table 39: Survey items that load on to factor 2 – teacher is confident in assessing the quality of research evidence

Factor 2 - teacher is confident in assessing the quality of research evidence	Loading	Item code
I am able to assess the quality of research	0.795	RE_Q4_7
Assessing the quality of the research	0.868	RE_Q5_3

Table 40: Survey items that load on to factor 3 – teacher is confident using and applying research evidence

Factor 3 - teacher is confident using and applying research evidence	Loading	Item code
Confidence discussing the research with others	0.672	RE_Q5_4
Confidence knowing what the research says about effective science teaching	0.811	RE_Q5_5
Confidence using research to inform how I think about my science teaching	0.874	RE_Q5_6
Confidence using research to change or develop my science teaching	0.871	RE_Q5_7
Confidence using research to persuade others to change or develop their science teaching	0.722	RE_Q5_8
Confidence monitoring and reviewing how I have applied research in my science teaching	0.699	RE_Q5_9

Table 41: Survey items that load on to factor 4 – teacher actively uses research evidence in practice

Factor 4 - Teacher actively uses research evidence in practice	Loading	Item code
Research plays an important role in informing my science teaching	0.727	RE_Q4_1
I have adopted new science teaching techniques based on findings from research	0.792	RE_Q4_5
I use research to help me decide how to implement new approaches in the classroom	0.813	RE_Q4_8
I believe that using research will help to improve pupils' science outcomes	0.614	RE_Q4_10
I use research to make changes to my science teaching	0.897	RE_Q4_11

Science pedagogy (SP) factor scores and loadings

The table below shows the Cronbach's alpha scores for each of science practice factors.

Table 42: The Cronbach's alpha scores for each of SP factors

Factor	Alpha score
Factor 5 - Teacher supports pupils to challenge misconceptions and review their learning	0.80
Factor 6 - Teacher uses practical work purposefully	0.84
Factor 7 - Teacher uses models to support understanding	0.85
Factor 8 - Teacher uses practices that support the retention and retrieval of knowledge	0.82
Factor 9 - Teacher helps pupils to develop scientific vocabulary	0.77
Factor 10 - Teacher supports pupils to direct their own learning	0.74

Tables 43-48 show the individual survey question items that constitute each of the science pedagogy factors following the factor analysis.

Table 43: Survey items that load on to factor 5 - teacher supports pupils to challenge misconceptions and review their learning

Factor 5 - teacher supports pupils to challenge misconceptions and review their learning	Loading	Item code
Revisit pupil's initial understanding as part of my teaching and learning strategy	0.632	SP_Q6_9
Encourage pupils to question their prior knowledge/experiences	0.679	SP_Q6_12
Prompt pupils to monitor how a task/activity is updating their knowledge	0.750	SP_Q6_14
Encourage pupils to review how successful their approach was for achieving the learning goal	0.808	SP_Q6_15

Table 44: Survey items that load on to factor 6 - teacher uses practical work purposefully

Factor 6 - teacher uses practical work purposefully	Loading	Item code
Use practical work as part of a sequence of learning	0.697	SP_Q9_5

Factor 6 - teacher uses practical work purposefully	Loading	Item code
Help pupils to draw links between the practical activity and the underlying scientific idea	0.818	SP_Q9_6
Model my scientific thinking to pupils when preparing them for practical work	0.771	SP_Q9_9
Encourage pupils to suggest explanations for why an experiment has produced a certain outcome	0.739	SP_Q9_10

Table 45: Survey items that load on to factor 7 - teacher uses models to support understanding

Factor 7 - teachers uses models to support understanding	Loading	Item code
Teach pupils why models are used	0.822	SP_Q9_1
Discuss the similarities and differences between the model and the scientific concept	0.782	SP_Q9_3
Encourage pupils to discuss the benefits and limitations of models	0.833	SP_Q9_4

Table 46: Survey items that load onto factor 8 - teacher uses practices that support the retention and retrieval of knowledge

Factor 8 - teacher uses practices that support the retention and retrieval of knowledge	Loading	Item code
Revisit key knowledge/concepts while preparing pupils to undertake tasks	0.608	SP_Q7_2
Provide worked examples of problems/concepts	0.766	SP_Q7_4
Give pupils tasks that can be solved step by step	0.801	SP_Q7_5
Frequently use activities that encourage pupils to draw on past knowledge	0.669	SP_Q7_6
Revisit taught concepts/knowledge after a period of time	0.642	SP_Q7_8

Table 47: Survey items that load on to factor 9 - teacher helps pupils to develop a scientific vocabulary

Factor 9 - teacher helps pupils to develop a scientific vocabulary	Loading	Item code
Explicitly teach pupils key scientific vocabulary	0.699	SP_Q10_2
Discussing how the meaning of words differs in science from everyday life	0.644	SP_Q10_3
Encourage pupils to use key scientific vocabulary in lessons	0.862	SP_Q10_8

Table 48: Survey items that load on to factor 10 - teacher supports pupils to direct their own learning

Factor 10 - teacher supports pupils to direct their own learning	Loading	Item code
Setting problems with increasing levels of difficulty	0.671	SP_Q6_6
Demonstrating how to approach new problems	0.765	SP_Q6_10
Encourage pupils to work with increasing independence	0.662	SP_Q6_11

Appendix 6: Survey analyses

A6.1 Change-over-time analysis

The following tables contain descriptive analysis of the final research use and science pedagogy factors at baseline and endpoint.

Table 49: Baseline factor descriptive analysis results

Factor	N	Minimum	Maximum	Mean	Std. Deviation
Factor 1	371	-1.65	1.44	-.008	.529
Factor 2	371	-1.90	1.14	-.012	.591
Factor 3	371	-1.84	1.67	-.014	.662
Factor 4	371	-1.91	1.67	-.006	.684
Factor 5	368	-1.83	1.37	.006	.568
Factor 6	368	-2.54	.94	-.037	.573
Factor 7	368	-2.41	1.68	-.028	.775
Factor 8	368	-1.62	.78	.004	.373
Factor 9	368	-2.56	.70	-.031	.510
Factor 10	368	-2.07	.98	-.005	.470

Table 50: Endpoint factor descriptive analysis results

Factor	N	Minimum	Maximum	Mean	Std. Deviation
Factor 1	206	-0.72	1.44	.308	.504
Factor 2	206	-1.82	1.14	.194	.497
Factor 3	206	-1.47	1.66	.332	.612
Factor 4	206	-1.57	1.68	.341	.618

Factor	N	Minimum	Maximum	Mean	Std. Deviation
Factor 5	203	-1.78	1.36	.129	.542
Factor 6	203	-1.99	.92	.113	.482
Factor 7	203	-1.92	1.66	.222	.727
Factor 8	203	-.77	.76	.098	.315
Factor 9	203	-1.18	.70	.092	.398
Factor 10	203	-1.83	1.00	.133	.423

The following table contains the full results of the change-over-time analyses conducted on the science pedagogy (SP) factors.

Table 51: Science pedagogy (SP) factors change-over-time results

Factor The teacher…	Baseline Mean	Endpoint Mean	Difference	95% confidence interval of the difference	Significant difference? (p-value)	Effect size (Cohen's d)	95% confidence interval of the effect size
supports pupils to challenge mis-conceptions and review their learning	-0.03	0.12	0.15	0.070-0.224	Yes (0.000)	0.275	0.129-0.420
uses practical work purpose-fully	0.01	0.10	0.09	0.030-0.150	Yes (0.003)	0.216	0.071-0.360

Factor The teacher…	Baseline Mean	Endpoint Mean	Difference	95% confidence interval of the difference	Significant difference? (p-value)	Effect size (Cohen's d)	95% confidence interval of the effect size
uses models to support understand-ing	0.01	0.19	0.19	0.093-0.277	Yes (0.000)	0.289	0.142-0.434
uses practices that support the retention and retrieval of knowledge	0.01	0.09	0.08	0.036-0.122	Yes (0.000)	0.262	0.117-0.407
helps pupils to develop scientific vocabulary	0.01	0.08	0.07	0.012-0.137	Yes (0.020)	0.172	0.028-0.316
supports pupils to direct their own learning	0.01	0.12	0.12	0.060-0.171	Yes (0.000)	0.299	0.152-0.444

A6.2 Awareness of EEF's Improving Science Guidance Report

The following tables display the results of the descriptive analyses conducted on the responses to a question about awareness of the EEF's Improving Secondary Science guidance report at baseline and endpoint, and project satisfaction questions asked at endpoint.

Table 52: Extent of respondents' engagement with the EEF's Improving Secondary Science Guidance Report at baseline and endpoint

I have…	Baseline Frequency	Baseline Valid %	Endpoint Frequency	Endpoint Valid %
never heard or seen the report	176	48	52	26
heard of or seen the report	107	29	71	36
heard of the report and used it to inform science teaching	83	23	76	38
heard of the report and used it to inform planning for my science teaching	1	<1	1	1

A6.3 Perceptions of overall programme usefulness

Table 53: Overall usefulness of the programme to science teaching (Evidence in Action, Journal Clubs and Research-2-Practice) and carrying out research in the classroom (Teacher-led RCTs)

Usefulness	Usefulness for science teaching - Frequency	Usefulness for science teaching - Valid %	Usefulness for classroom research - Frequency	Usefulness for classroom research - Valid %
Not at all useful	4	2	0	0
Not very useful	6	3	0	0
Mixed views	57	29	1	<1
Very useful	77	39	2	<1
Extremely useful	32	16	7	<2
Not applicable	24	12	0	0

A6.4 Perceptions of the usefulness of the projects' training, resources, and support

Survey items on training, support, and resources by project

Table 54: Survey items that constitute the analysis categories: training

Training analysis category	Survey items
Training sessions/workshops	Evidence in Action, Research-2-Practice, Teacher-led RCTs - Training sessions/workshops led by project team Journal Clubs – Online training and facilitator training led by the Chartered College of Teaching

Table 55: Survey items that constitute the analysis categories: resources

Resources analysis category	Survey items
Resources that have translated evidence for teacher use	Evidence in Action– Lesson plans Research-2-Practice – Lesson plans
Resources that support participant translation of evidence	Journal Clubs – Critical assessment and implementation tools
Summarised evidence sources/signposting to such evidence	Research-2-Practice – Research summaries Evidence in Action – Signposting to evidence sources (i.e., the EEF's Teaching and Learning Toolkit/Improving Secondary Science Guidance report; the IOP's Students' Misconceptions Database) Teacher-led RCTs – Signposting to research evidence on science pedagogy
Primary evidence sources	Journal Clubs – Research papers
Resources to support doing research	Teacher-led RCTs – Resources to help design classroom RCTs and StatsWizard

Table 56: Survey items that constitute the analysis categories: support

Support analysis category	Survey items
Support beyond training sessions (e.g., email, phone, QA sessions from project delivery team)	Research-2-Practice (mentors only) Evidence in Action Journal Clubs Teacher-led RCTs
Mentor support for using lesson plans	Research-2-Practice (mentees only)
Meetings/forums	Journal Clubs – online Journal Clubs meetings

Usefulness of the combined elements of training, resources, and support

Table 57: Mean usefulness of the combined elements across the Evidence in Action, Journal Clubs and Research-2-Practice projects[51]

Element	N	Minimum	Maximum	Mean	Standard Deviation
Training	153	1	5	3.71	0.80
Resources	174	1	5	3.74	0.79
Support	139	1	5	3.76	1.03

Table 58: Mean usefulness of combined elements of Teacher-led RCTs project

Element	N	Minimum	Maximum	Mean	Standard Deviation
Training	11	4	5	4.18	0.40
Resources	11	1.00	4.67	3.2121	1.21
Support	11	.00	5.00	3.2727	1.90

[51] This table consists of the mean usefulness rating given by all of the participants involved in the Evidence in Action, Journal Clubs and Research-2-Practice projects. These participants were all asked the same survey question concerning the usefulness for their **science teaching**, as their projects shared the same core aim of supporting teachers to use research. The Teacher-Led RCT project aimed to support teachers to conduct classroom research and so was asked instead about usefulness for **undertaking research**. This distinction in questioning between the projects also applies to the mean usefulness ratings for training, resources, and support displayed in Tables 62-65.

Usefulness of the projects' training components

Table 59: Mean usefulness of the different training elements of Evidence in Action, Journal Clubs and Research-2-Practice (combined)

Usefulness	Frequency	Valid %
Not at all useful	1	1
Not very useful	6	4
Mixed views	53	35
Very useful	69	45
Entirely useful	24	16
Total	**153**	**101**

*Due to rounding, the percentage may not sum to 100.

Table 60: Mean usefulness of the training elements of Teacher-Led RCTs

Usefulness	Frequency	Valid %
Not at all useful	0	0
Not very useful	0	0
Mixed views	0	0
Very useful	9	82
Entirely useful	2	18

Usefulness of the projects' resource components

Table 61: Mean usefulness of the resource elements across Evidence in Action, Journal Clubs and Research-2-Practice (combined)

Mean usefulness rating[52]	Frequency	Valid %
1 - Not at all useful	1	1

[52] Participants were asked to rate the usefulness of the resources that they had received during their project on a five-point scale, where 1 was 'Not at all useful' and 5 was 'Entirely useful'. They could also select 'I have not

Mean usefulness rating[52]	Frequency	Valid %
1.50	0	0
2 - Not very useful	4	2
2.50	8	5
3 - Mixed views	39	22
3.50	32	18
4 - Very useful	46	26
4.50	21	12
5 - Entirely useful	23	13
Total	**174**	**99**

*Due to rounding, the percentages may not sum to 100

Table 62: Mean usefulness of the resource elements of Teacher-led RCTs

Mean usefulness rating	Frequency	Valid %
1 - Not at all useful	0	0
2 - Not very useful	0	0
3 - Mixed views	2	18
3.50	1	9
3.67	3	27
4 - Very useful	2	18
4.67	2	18
5 - Entirely useful	1	9
Total	**11**	**99**

accessed this'. The mean was then calculated across the items to produce a mean usefulness rating overall for all the resources that the participant had received.

Due to rounding, the percentages may not sum to 100

Usefulness of the projects' support components

Table 63: Mean usefulness of the support elements across Evidence in Action, Journal Clubs and Research-2-Practice (combined)

Mean usefulness rating[53]	Frequency	Valid %
1 - Not at all useful	5	4
1.50	0	0
2 - Not very useful	10	7
2.50	1	1
3 - Mixed views	30	22
3.50	7	5
4 - Very useful	44	32
4.50	10	7
5 - Entirely useful	32	23
Total	**139**	**101**

Due to rounding, the percentages may not sum to 100

Table 64: Mean usefulness of the support elements of Teacher-led RCTs

Mean usefulness rating	Support - Frequency	Support - Valid %
Not at all useful	0	0
Not very useful	1	11
Mixed views	2	22

[53] Participants were asked to rate the usefulness of the forms of support that they had received during their project on a five-point scale, where 1 was '*Not at all useful*' and 5 was '*Entirely useful*'. They could also select *'I have not accessed this'*. The mean was then calculated across the items to produce a mean usefulness rating for the overall support that the participants had received.

Mean usefulness rating	Support - Frequency	Support - Valid %
Very useful	2	22
Entirely useful	4	44
Total	**9**	**99**

Due to rounding, the percentages may not sum to 100

A6.5 Extent to which participants used their learning from their projects

Table 65: Frequency with which programme respondents used the learning from their project in the classroom (combined)

	Frequency	Valid %
Never	5	3
Rarely	33	19
Sometimes	78	44
Often	57	32
Always	3	2
Total	**176**	**100**

Table 66: Frequency with which respondents used their learning from their project in the classroom by project

	Evidence in Action - Frequency	Evidence in Action - Valid %	Journal Clubs - Frequency	Journal Clubs - Valid %	Research-2-Practice - Frequency	Research-2-Practice - Valid %	Teacher-Led RCTs - Frequency	Teacher-Led RCTs - Valid %
Never	1	2	1	1	3	11	0	0
Rarely	4	8	15	17	14	52	0	0
Sometimes	23	44	42	48	9	33	4	40
Often	23	44	28	32	1	4	5	50
Always	1	2	1	1	0	0	1	10
Total	**52**	**100**	**87**	**99**	**27**	**100**	**10**	**100**