University of Southampton

Faculty of Environmental and Life Sciences

School of Psychology

Exploring the Factors Contributing to Fidelity in Literacy Interventions

by

Claudia Mary Stubington

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Abstract

Literacy is a core academic skill, however, not all children learn to read and write successfully through traditional methods of instruction. Literacy interventions are an important tool to support struggling learners, but their impact can be undermined when they are delivered without fidelity. A systematic review was conducted to explore factors contributing to fidelity in literacy interventions. 11 studies were identified, four investigated possible contributing factors to fidelity while seven investigated approaches to support fidelity. The findings of these studies indicated several environmental and individual factors, including class size and interventionists' level of education, can impact the intervention fidelity. Several approaches were found to have a positive impact in supporting fidelity, including training, ongoing support through coaching and feedback, and finally self-monitoring approaches. While these findings are encouraging there were methodological flaws within the body of research and a general lack of replication, and none of the approaches identified reach the criteria to be considered evidence-based practice. We must therefore be cautious in interpreting these findings and future research will need to work to replicate this work within a UK context. While the evidence is not yet conclusive it does provide the starting point for future research and suggests implications for developing practice.

Precision teaching is an evidence-based intervention designed to support learners to reach fluency in a target skill. While precision teaching has been shown to be effective in supporting the development of a range of core academic skills there is evidence to suggest that it is often delivered without intervention fidelity. The current mixed methods study collected both quantitative data, from questionnaires related to the fidelity of intervention delivery, and qualitative data, from participants responses in semi structured interviews. Interview data was then thematically analysed to identify factors contributing to faithful delivery of the precision teaching intervention. Teachers and TAs responses indicated that there was variability in the delivery of a precision teaching intervention. Teachers and TAs outlined a range of factors which played a role in the effectiveness of the intervention including the emotional state and motivation of learners, the use of an individualised approach, and the quality of delivery. Teachers and TAs both indicated that their skills and understanding of the intervention and the systemic support they received aided intervention fidelity. Teachers reported competing demands and an overall lack of time undermined their ability to deliver the intervention faithfully. TAs indicated that scheduling conflicts, and their own lack of control over their workload undermined intervention fidelity. The findings of this study present clear implications for future practice and particularly highlight the need for careful planning, incorporating leadership perspectives and sufficient allocation of resources, in delivering precision teaching interventions faithfully.

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I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

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3. Where I have consulted the published work of others, this is always clearly attributed;
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Definitions and Abbreviations

Intervention fidelity..... The delivery of an intervention in line with programme specifications Synonyms: faithful delivery, treatment fidelity, programme fidelity, treatment integrity

Functional literacy skills……..Reading and writing skills necessary to manage the literacy demands of daily life and employment

Intervention..... A focused teaching program or approach that differs from whole class teaching approaches with the aim of supporting the development of specific skills

Interventionist.....The individual tasked with working directly with the learning to deliver the intervention Synonyms: intervention deliverers

Implementer..... The individual applying the intervention within an educational setting either at an individual or systemic level

Celeration chart..... A semi-logarithmic chart used to track progress within a precision teaching intervention

SEN..... Special educational needs

SENCo..... Special educational needs coordinator. A teacher with responsibility for supporting children with special educational needs within an educational setting

TA..... Teaching assistant

PT……Precision Teaching

Chapter 1 A Systematic Literature Review Exploring the Factors and Approaches that Contribute to Fidelity in Literacy intervention

1.1 Introduction

Literacy is a skill that requires a child to develop both receptive skills - understanding and accessing written communication through reading - and expressive skills - producing their own communication through writing (Fransman, 2005). Both reading and writing are complex, higher level cognitive skills, that require children to develop fluency in a range of underpinning cognitive elements, including understanding of language and narrative, phonological awareness, knowledge of graphemes, and the ability to link phonic sounds to graphic representations (Whitehurst & Lonigan, 1998).

Beyond the basic conceptualisation of literacy as a skill it has also been defined by UNESCO as a fundamental human right (Wagner, 2011). For those individuals who do not develop functional literacy skills the impact may be profound. The world literacy foundation (Cree, Kay & Steward, 2012) found that functional illiteracy was associated with a range of negative economic outcomes including limited employability, losses in productivity and opportunities for the acquisition of wealth, and limited capacity to access technology. Additionally, illiteracy was found to be linked with poor health outcomes, higher proportions of crime and incarceration, a greater reliance on welfare support or benefits and a greater risk of having children who also experienced difficulties with literacy. This negative impact extends beyond individuals and the 2012 report estimated that illiteracy costs the global economy $1.19 trillion annually.

Given the significant negative impact of not developing functional literacy skills, it is not surprising that considerable attention has been given within our education system to developing children's competency in reading and writing. The National Literacy Strategy, introduced in 1998, was designed to support primary school children across the United Kingdom to reach the level of literacy required by key stage two national curriculum tests (Frederickson & Cline, 2009). More recently the national curriculum highlights the need to develop written communication skills across all subject areas (Department of Education, 2013).

However, the evidence suggests that these national literacy strategies are not effective for all children. Despite the emphasis placed on developing literacy skills by The National Literacy Strategy in 2002, only 75% of children hit the target of desired literacy proficiency by age 11 (Fredrickson & Cline, 2009). More recently, in 2019, 75% of key stage one and 73% of key stage

two children were found to have met expected standards for reading (Department for Education, 2019). In writing assessments, 69% of key stage one and 78% of key stage two children met expected standards (Department for Education, 2019). Therefore, while traditional literacy instruction and whole classroom strategies may be effective for the majority of children, there is a smaller yet significant subgroup of children for whom these forms of literacy learning are less effective. For those children who do not make the desired level of progress in traditional literacy instruction, targeted intervention has been shown to lead to positive gains in literacy skills, both in the short and long term (Zimmerman, Rodriguez, Rewey, & Heidemann, 2008).

A range of intervention tools have been developed to support successful literacy acquisition and many of these intervention programmes have been shown by multiple studies to be effective in supporting the development of targeted literacy skills (Brooks, 2016). However, while within the field of intervention research there is often sufficient evidence collected to support the positive impact of interventions, in many cases this evidence-based practise encounters significant obstacles when it comes to implementation in real world settings (Bauer, Damschroder, Hagedorn, Smith, & Kilbourne, 2015). The field of implementation science developed within the healthcare field in response to this breakdown of transfer between research evidence and real-world delivery, which may take two forms: lack of implementation of the evidence-based intervention, or implementation of the intervention with a low degree of fidelity. Bauer et al highlight that a range of factors including lack of knowledge and skills in frontline providers, insufficient resources and divergence between systemic goals and research findings can all undermined the implementation of evidence-based interventions.

While a range of research has sought to establish the efficacy of interventions to support the development of core literacy skills there has been limited focus historically on the implementation of these interventions and specifically the degree of fidelity with which they are implemented. Santacroce, Maccarelli and Grey (2004) point out that the validity of such findings regarding the impact of interventions are related to the degree of fidelity with which the intervention is delivered. Fidelity is often referred to using a range of terms including implementation fidelity (McIntyre et al, 2005; Vernon-Feagans, Bratsch- Hines, Varghese, Bean & Hedrick, 2015), intervention fidelity (Davenport, Alber-Morgan & Konrad, 2019), procedural fidelity (Browder, Trela & Jimenez, 2007), treatment integrity (Zoder-Martell et al, 2013). While precise definitions of fidelity may vary slightly between studies common themes outline the delivery of the intervention as designed (Swanson, Wanzek, Haring, Ciullo & McCulley, 2013) by adhering to the original intervention plan (Santacroce et al, 2004) and delivering a high proportion of intervention components (Browder et al, 2007; Roberts & Leko, 2013).

If interventions in research studies are not delivered with fidelity, then the degree to which reliance can be placed on the findings of these studies is called into question. Additionally, if a positive impact is found when a programme is delivered faithfully, then it is vital that the programme be delivered with the same fidelity when implemented in a practical educational setting, or the positive impact may be lessened (Stein et al, 2008). Fidelity of intervention delivery is crucial to ensuring the positive impact of interventions for learners (Cook & Cook, 2013) and Kim, Linan,-Thompson and Misquitta (2012) go so far as to identify fidelity of intervention as one of the factors critical to successfully delivering reading comprehension instruction to students with learning difficulties.

The role of fidelity to intervention has come to prominence within the field of intervention research in the last two decades. In 2000 the No Child Left Behind Act was passed in the United States in parallel with other legislative programmes across the world, including the aforementioned National Literacy Strategy in the United Kingdom (Daniel & Lemons, 2018). These legislative programmes sought to encourage the adoption of evidence-based programmes to support all children, including those with learning difficulties, to make academic progress as well as highlighting the central role of reading in academic success (Stein et al, 2008, Daniel & Lemons, 2018). Beyond the specific focus on evidence-based practice in literacy instruction, the No Child Left Behind Act sought to hold educators accountable for the academic attainment of their students (McIntyre et al, 2005). Given this focus on evidence-based practice and accountability the importance of delivering interventions with a high degree of fidelity has been increasingly emphasised within the literature (Simpson, LaCava & Graner 2004). Therefore, in the last 20 years there has been a growth in the literature seeking to develop an understanding of factors which may affect fidelity when interventions are delivered in an educational context, particularly in the United States (McIntyre et al, 2005; Stein et al, 2008; Zvoch, 2009; Daniel & Lemons, 2018)

While the growing emphasis on the importance of intervention fidelity has resulted in an increasing number of studies regarding the factors which can impact fidelity there has not, to date, been a comprehensive review of the literature in this field. Without a clear and evidence-based understanding of the barriers to intervention fidelity it is not yet possible to implement comprehensive programmes to minimise these barriers and support intervention fidelity. Therefore, the current review aims to develop such an understanding of barriers to fidelity and approaches which may effectively overcome them. To that end, in this review studies which have directly investigated the role of contextual factors in delivering literacy interventions with fidelity will be identified, as well as those which have sought to identify useful approaches in supporting intervention fidelity. The findings of these studies will then be synthesised, the strength of the literature in this field evaluated, and the implications for future research and practice discussed.

Given the long-term impacts of failure to develop functional literacy skills and the growing societal demand for evidence-based practice within this field, it is important to understand which factors play a role in ensuring intervention fidelity and how better to support faithful delivery of reading interventions in the future. To that end the current systematic literature review will seek to answer the research question, what are the factors which impact the fidelity with which literacy interventions are delivered in schools?

1.2 Method

1.2.1 Search Strategy

Three databases were used as sources of literature for this review, PsychInfo, Web of Science, and Education Resources Information Centre (ERIC). Search terms were selected to specify a focus on literacy, interventions, schools, and fidelity. Synonyms were identified through the use of online sources, and through reading papers related to the target field identified in initial scoping searches. While this initial reading identified 'faithful' as the most commonly used synonym for fidelity, a review of identified papers when the search had been completed identified another possible synonym, 'integrity,' therefore the search was conducted again with this additional search term. For a complete outline of search terms see appendix A.

During the search, synonyms were connected using the search command 'OR' while search terms in different areas were combined using the search command 'AND'. In order to ensure the widest possible field of search asterisks were used at the end of individual search terms to ensure that articles using words with different endings, for example, plurals or the past tense were correctly identified. Due to the high number of health and medical treatment related articles initially identified, additional search terms related to these areas were combined with the original search using the search command 'NOT' to eliminate studies related to this field from search parameters. Due to the high number of results returned, filters were applied to limit search results to published journal articles only, thereby excluding unpublished and grey literature. Identified papers were further filtered to limit results to English language only.

1.2.2 Inclusion and exclusion criteria

Search results from the three databases were collated and duplicates were deleted. Predetermined inclusion and exclusion criteria were identified (see Table 1), and titles and abstracts were reviewed to identify papers which met inclusion criteria. Full texts were then

retrieved for those papers which had been identified as meeting inclusion criteria. Selected full texts were subjected to preliminary review and those that did not meet inclusion criteria were excluded (N=3). Reference lists of selected papers were reviewed and titles and abstracts of papers which might meet inclusion criteria were reviewed. Papers identified by this method which met inclusion criteria were thereafter included in the review (N=2) leaving a total of 11 papers selected for critical evaluation and inclusion in the systematic literature review. Further details of the inclusion and exclusion process are outlined in the PRISMA flow diagram (Figure 1).

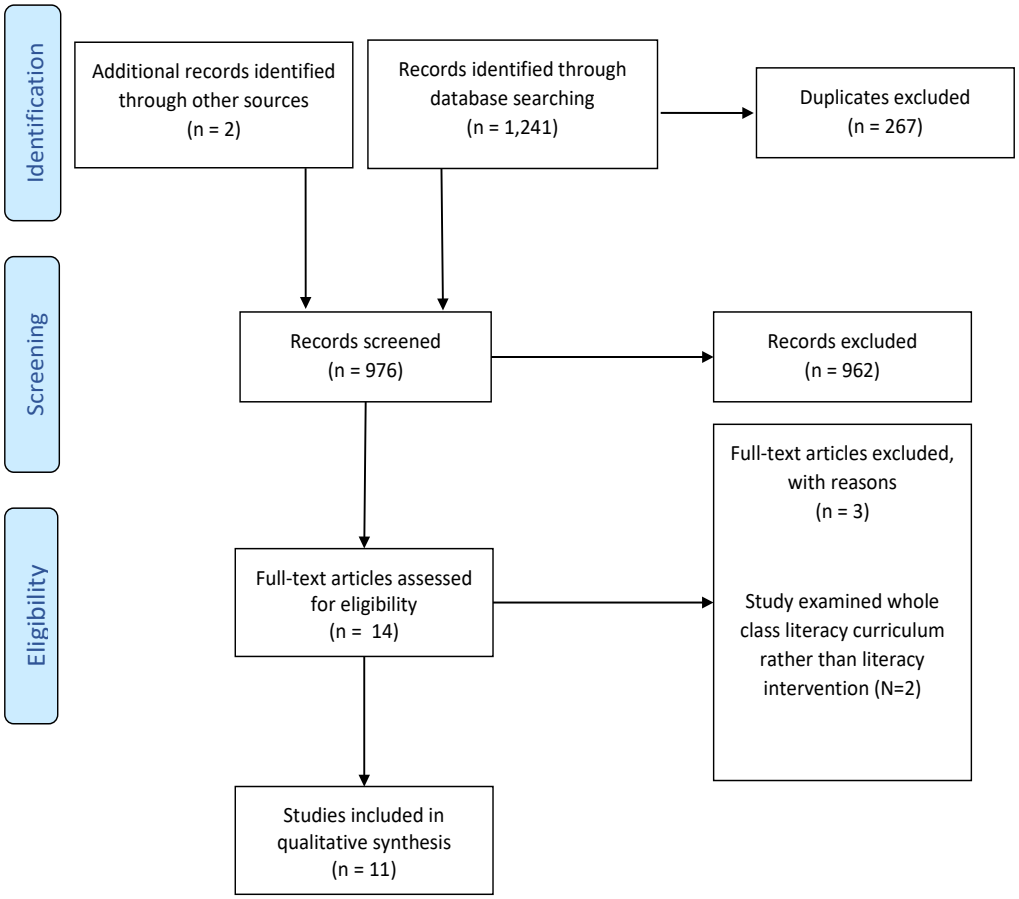


Figure 1 PRISMA flow diagram

Table 1 *Inclusion and exclusion criteria*

Include	Exclude
Papers directly investigating the factors related to intervention fidelity either using qualitative, correlational or variable manipulation designs	Papers only examining the impact of fidelity on student outcomes without direct investigation of factors which might have impacted fidelity
English language	Not English language

Studies investigating fidelity to structured intervention programmes, delivered to small groups or individual students as an addition or alternative to traditional literacy curriculums.	Studies investigating fidelity to whole class literacy curriculums, or unstructured ad hoc literacy interventions, for example the use of a writing frame.
Studies which investigated the fidelity of intervention delivery by school staff, teachers, or TAs	Studies which investigated the fidelity of intervention delivery by parents or peers
Papers investigating factors affecting intervention fidelity for functional literacy interventions	Papers investigating factors affecting intervention fidelity for interventions not relating to core literacy, for example, behaviour management, numeracy interventions or higher-level literacy interventions such as persuasive writing
Interventions taking place in either a primary or secondary school setting, specialist or mainstream	Interventions taking place in a pre-school, nursery, further or higher education setting.
Empirical research stud published in an academic Journal and having complied with a peer review process	Non empirical and unpublished research, for example, editorial or thesis.
Interventions focused on developing first language literacy.	Interventions to support the development of written communication in a second language.

1.2.3 Synthesis

The 11 studies identified as meeting inclusion criteria were then reviewed, a data extraction table was used to identify key aspects, and their findings synthesised. In the first-place studies were sorted by their methodological approaches, with studies which used observational techniques to identify contributing factors to fidelity analyse separately from those which used

experimental techniques in which approaches to supporting fidelity factors were manipulated. The findings of studies employing observational techniques were then further subdivided based on the area of focus of the fidelity factors identified with findings relating to contextual factors, interventionist factors, and intervention factors analysed separately. All seven studies making use of experimental designs were focused on approaches to supporting fidelity, however these findings where further subdivided based on their area of focus. Findings from papers which explored the impact of training, ongoing support and self-monitoring approaches were analysed separately. For further details please see figure 2.

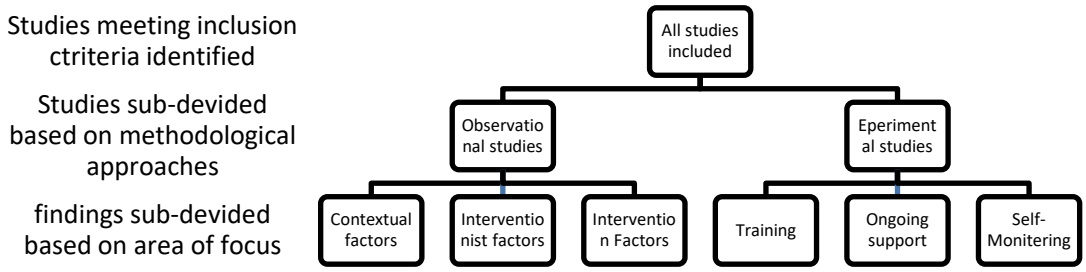


Figure 2 Synthesis process

1.2.4 Quality assessment

A range of methodological approaches were used in the studies identified for this review to establish factors which might have an impact on intervention fidelity. Several studies sought to identify implementation factors which can undermine or support intervention fidelity. These studies made use of qualitative or correlational methods to identify possible relationships between situational factors and intervention fidelity. In order to assess the quality of these studies adaptions of the CASP cohort study (Appendix B) and qualitative study (Appendix C) checklists were employed.

Beyond the identification of relationships through qualitative or correlational approaches, several studies sought to directly assess the effectiveness of various approaches in supporting intervention fidelity. These studies employed either group comparisons or single subject multiple baseline comparisons to investigate the impact of the selected fidelity maintenance approaches. Due to the high proportion of single subject designs it was important to implement a quality assessment tool specifically designed for this type of study. Furthermore, to ensure a successful synthesis of the findings on the impact of approaches to support fidelity, an evaluation tool that could assess the quality of group comparisons in a comparable manner was desirable. To that end, the group research quality indicators and single subject research quality indicators outlined

in Reichow, Volkmar and Cicchetti (2008) were used as the basis for a checklist to establish the strength of each study. As these tools were originally developed as a method of identifying evidence-based practice in autism intervention research, the indicators were adapted to meet the demands of the current study. Namely all references to autism, and a clinical sample were removed, as were the requirement to provide age and cognitive assessment results of participants. The quality indicator related to fidelity were also removed as, in the studies under investigation, measurements of fidelity were treated as the dependent variable and therefore those quality indicators were applied. For further details of the adapted quality indicator checklists, see Appendix D. The overall strength of the evidence base was then evaluated using Reichow et al's criteria for treatments to be considered evidence-based practice.

1.3 Results

1.3.1 Study characteristics

Eleven Journal articles were identified as meeting the outlined inclusion criteria based on the systematic search procedure previously outlined. Their publication dates ranged from 2005 to 2020. All 11 papers were empirical studies which aimed to explore contributing factors to intervention fidelity in literacy interventions. Four studies, quantitative and qualitative, explored the implementation factors which can affect fidelity in literacy interventions using observational approaches. Seven quantitative studies investigated the efficacy of a range of approaches used to support fidelity in literacy interventions using experimental methodologies. The studies were all carried out in a western cultural context with investigations conducted in America and Australia.

The findings of these studies are outlined in two sections, the first relating to implementation factors which may have an impact on intervention fidelity, and the second providing an overview of the research on approaches used to support fidelity. The strength of the research is then evaluated. Table 2 provides an overview of the key characteristics of the studies outlined.

The aim of the current review is to investigate factors affecting fidelity to intervention, both looking at contextual, intervention, and individual factors which can affect fidelity and approaches which can be used to support fidelity. Therefore, while several of the papers outlined also investigated the impact of fidelity on student outcomes these findings were beyond the scope of the current review.

Table 2 *Study characteristics*

Section	Study	Design	Country	Setting	Participants	Intervention
Approaches to Fidelity Maintenance	Davenport, Alber-Morgan and Konrad (2019)	Multiple baseline comparison	USA	1 Private Montessori school	3 teachers	Reading Racetrack (Erbey, McLaughlin, Derby, & Everson, 2011)
	O'keeffe, Slocum and Magnusson (2013)	Multiple baseline comparison	USA	2 elementary schools	5 teachers	Corrective Reading: Decoding (Engelmann, Carnine, & Johnson, 1999)
	Zoder-Martell et al (2013)	Multiple baseline comparison	USA	Elementary schools	4 teachers/ teaching assistants	Repeated Reading (Samuels,1979) Listening Passage Preview (Rose & Sherry, 1984)
	Vernon-Feagans, Bratsch-Hines, Varghese, Bean and Hedrick (2015)	Group comparison	USA	9 elementary schools	58 teachers	The Targeted Reading Intervention (Vernon-Feagans, Amendum, Kainz, & Ginsburg, 2009)

	Stein, Berends, Fuchs, McMaster and Saenz (2008)	Randomised control trial	USA	71 elementary schools	224 teachers	Kindergarden peer assisted learning strategies (KPALS) (Fuchs et al, 2001)
	Browder, Trela and Jimenez (2007)	Multiple baseline comparison	USA	1 middle school	3 teachers	Structured literacy intervention with adapted text.
	Roberts and Leko (2013)	Multiple baseline comparison	USA	2 middle schools	3 teachers	Structured literacy intervention with adapted text.
Implementation factors	Zvoch (2009)	Hierarchical linear model	USA	42 elementary schools	100 teachers	Breakthrough to Literacy (Tancredo, 2001) Voyager Universal Learning (Voyager Expanded Learning, 2004)
	Daniel and Lemons (2018)	Cross sectional study	USA	*Not specified*	174 teachers	*Not specified*
	McIntyre et al (2005)	Qualitative study	USA	17 schools	35 teachers	Carbo Reading (Carbo, & Cole, 1995) Book Club

Main, Blackhouse, Jackson, and Hill (2020)	Qualitative study	Australia	1 secondary school	5 Teaching assistants	Reading Mastery (Reading Mastery, 2008)

1.3.2 Synthesis of findings

1.3.2.1 Implementation factors

When delivering an evidence-based literacy intervention, the aim is to do so with a high degree of fidelity to prevent alterations and adaptions being made in delivery which might undermine its overall impact. However, it is important to note that reading interventions are often developed in academic settings, such as universities and laboratories, and by researchers rather than practitioners (Stein, Berends, Fuchs, McMaster & Saenz, 2008). When an intervention is implemented in an in vivo setting, a drop in fidelity is often observed due to the unforeseen impact of a variety of contextual implementation factors. Four studies sought to develop an understanding of these factors and identified several relating to the structural context in which the intervention is delivered, and others related to the individuals who delivered the intervention.

1.3.2.1.1 Contextual factors.

Within the school setting, there are a variety of structural, organisational and administrative factors which may impact the degree of fidelity with which interventions are delivered (Stein et al, 2008; Daniel & Lemons, 2018; Zvoch, 2009). Zvoch (2009), and Daniel and Lemons (2018) attempted to identify some of these factors which may play a role in determining fidelity.

Zvoch (2009) investigated faithful adherence to intervention models in Breakthrough to Literacy (Tancredo, 2001) and Voyager Universal Learning (Voyager Expanded Learning, 2004) literacy intervention programmes in 100 classrooms across 42 elementary schools in the United States. Programme specific observation checklists were used by the researchers during three observations of intervention delivery over a period of seven months to identify the percentage of intervention components faithfully delivered. They found that variability in overall programme adherence and the degree to which programme adherence changed over time was largely attributable to school site, 72% and 64% respectively. Indicating that differences in intervention setting may impact intervention fidelity. They then made use of a hierarchical linear model to explore the relationship between a variety of factors and faithful adherence to intervention model. The contextual factors found to be related to faithful adherence were the size of the class

and the school enrolment, that is the number of students enrolled in the school. Larger class sizes were associated with lower overall intervention fidelity, with each additional student being related to a 0. 9% drop in adherence. Larger schools were also found to have lower overall intervention fidelity, though their fidelity was found to increase over time. Fidelity in smaller schools remained stable over time at an overall higher level. While the study conducted observations of fidelity over a period of seven months there was no later follow up observation. Therefore, whilst fidelity in settings within smaller enrolments was higher overall, it is not clear whether this difference would have persisted in the longer term, given the increase in fidelity in schools with higher enrolment over the observation period.

In addition to structural factors of the school itself, organisational factors around the intervention have also been suggested as having an impact on fidelity. Daniel and Lemons (2018) Investigated factors impacting intervention sustainability which they defined as "the persistent long-term use of a practice with high levels of fidelity" p.g. 4. To this end they used teacher surveys to collect data regarding contextual factors that would support them to deliver an intervention with fidelity. Teachers were given five options in two surveys and asked to select those which supported them to faithfully deliver a range of interventions including literacy intervention programmes. The factor most consistently identified as supporting intervention fidelity was 'more planning time' (S1= 61.46%, S2=67.95%). With 'regular training' (S1= 39.58%, S2=35.90%) and then 'better quality Training' (S1=36.46%, S2=19.83%) being the second and third most commonly identified systemic factors. While these factors were not generated by participants, a high proportion of participants identified the organisational factor of planning time as impacting fidelity and that, in general, training amount and quality was identified as crucial to supporting fidelity by more than 25% of participants. These findings suggest that how the intervention is organised and set up may play an important role in intervention fidelity.

The factors least consistently identified by Daniel and Lemons' (2018) participants were 'more support in school' (S1= 29.17%, S2=28.12%) and finally 'online support' (S1= 15.62%, S2=14.10%). However, more than 25% of participants did identify in-school support as important for facilitating correct implementation. In addition to these findings, direct support was suggested to be important by responses in semi-structured interviews in Main, Blackhouse, Jackson, and Hill's (2020) study regarding the implementation of the direct instruction literacy programme, Reading Mastery (Reading Mastery, 2008). According to Main et al., coaching and mentoring supported teachers in faithfully delivering the intervention. Additional support in the form of having opportunities to observe others using the intervention was identified as something that would have been useful and supporting fidelity. It is interesting to note that the importance of additional support seems to receive greater priority in Main et al.'s study, which may reflect the

important role of mentoring and coaching in the Reading Mastery intervention under investigation in this study. It may also reflect the more open-ended method of data collection via semi structured interviews where participants could generate their own responses rather than selecting from a list of options. On the whole it seems that ongoing support can be useful to assist participants to deliver interventions with fidelity, though this may be less readily identified in interventions which do not include or prioritise this aspect.

In summary, both the structure of the school in the form of school and class size may have a role in determining intervention fidelity, and also organisational factors such as planning time and training. Further support available may also play a role in intervention fidelity, which may be particularly evident in interventions for which coaching, and mentoring is a core component.

1.3.2.1.2 Interventionist factors

In addition to structural factors of the context within which the intervention is delivered, the person delivering the intervention also plays a significant role in how it is delivered (Hulleman and Cordray, 2009). Three papers, Daniel and Lemons (2018), Zvoch (2009) and McIntyre et al. (2005) sought to develop a better understanding of factors intrinsic to those delivering the intervention which might play a role in fidelity.

Zvoch (2009) explored a range of factors which affected fidelity to intervention in the Breakthrough to Literacy and Voyager Universal Learning literacy interventions. As well as the contextual factors identified above, they also identified several factors related to the teacher delivering the intervention which were associated with the degree of intervention fidelity. The level of education the teacher had received was found to be significantly related to overall intervention fidelity. Perhaps counterintuitively teachers with higher levels of education demonstrated lower fidelity, with 7% fewer identified key intervention steps being implemented by teachers with a master's degree than by teachers with a bachelor's degree. It is important to note that based on a sample of 100 teachers, with 56% holding a master's degree, this study represented one of the largest samples in the identified literature.

In addition to the general level of education of the intervention implementer, their level of understanding and skill with the intervention may also play a role in fidelity. In their 2005 study, McIntyre et al. explored the fidelity of intervention of a range of literacy interventions and curriculum programmes. For programmes which were delivered with a low degree of fidelity, of which two were literacy interventions - Carbo Reading (Carbo, & Cole, 1995) and Book Club - teachers were interviewed and asked what factors prevented them from delivering the intervention with fidelity. For both reading interventions teachers identified a limited

understanding of the intervention, arising from minimal professional development to improve participants' knowledge and understanding of the intervention or in one case none at all. Furthermore, Zvoch (2009) found that over the course of the intervention female teachers increased intervention adherence by 11%. This suggests, at least for women, that in addition to understanding derived from training and professional development, experience and familiarity with the intervention may play a role in fidelity.

On the whole, these findings suggest that the characteristics of the individual delivering the intervention may affect implementation fidelity, particularly characteristics related to their education. General level of education may impact how participants take on board and implement interventions as might their understanding and experience of the intervention itself.

1.3.2.1.3 Intervention factors

It should be noted that, while the context in which an intervention is delivered and who it is delivered by are clearly important in determining fidelity, Zvoch (2009) also suggested that fidelity of intervention delivery may be related to the intervention that was used. In this study, Voyager Universal Learning was shown to have higher initial intervention fidelity (89%) which decreased (5%) over the course of the intervention. On the other hand, Breakthrough to Literacy, while having initially lower intervention fidelity (75%), showed a small increase (1%) in adherence to delivery over the course of the study. This finding suggests that there may be factors intrinsic to the intervention itself which affect the fidelity with which it is delivered, though these were not further explored within the study. Factors intrinsic to intervention design have been shown to affect the degree to which an intervention is implemented following training (Burke & Hutchinson, 2007); some authors have suggested that it may also impact whether the intervention is delivered faithfully (McIntyre et al, 2005). However, none of the studies identified for this review directly investigated the specific factors of an intervention which may play a role in supporting or undermining the fidelity of intervention implementation.

1.3.2.2 Approaches to fidelity maintenance

Seven studies were identified which explored the impact of a range of approaches that can be utilised to increase fidelity to intervention in a range of literacy interventions. Two of these examined the impact of training on fidelity. Three investigated whether ongoing support, through assistance, coaching or feedback, was a viable strategy for supporting fidelity. Finally, two studies looked at the impact of self-monitoring on intervention fidelity.

1.3.2.2.1 Training

Training is a common factor of intervention research which has been identified as possibly having a role in the fidelity of intervention implementation. However, it is important to establish through direct investigation what role training plays in supporting intervention fidelity, and particularly how various kinds of training might have differing impact. Davenport et al (2019) sought to investigate the role of initial training in supporting intervention fidelity. While O'keeffe, Slocum and Magnusson (2013) investigated whether additional training designed to develop deliverers' fluency in the target intervention would result in higher levels of intervention fidelity.

Davenport et al. (2019) investigated the impact of the provision of behavioural skills training on fidelity of delivery of the Reading Racetrack intervention (Erbey et al, 2011) in comparison to the provision of written instructions. Within the behavioural skills training participants were provided with a general overview of the intervention, and it was then modelled and participants were given the opportunity to practise. Practise was repeated until participants were able to complete all 12 steps of the intervention with 100% accuracy without feedback from the trainer. The impact of this training was investigated through a multiple baseline comparison of fidelity of delivery. Prior to training with only written instructions provided, participants demonstrated very low fidelity. During training all teachers hit 100% accuracy with no feedback within two training sessions and maintained this level of fidelity for at least four sessions as well as at one or two weeks after training. This suggests that training is necessary to support participants to deliver literacy interventions with fidelity, and that opportunities to practise until a criterion level of fidelity is reached may support faithful delivery. However, as the comparison in this study was to the provision of a written outline of the intervention it is not clear which aspect of the training led to high levels of fidelity, and whether it would have been as effective without the criterion accuracy level requirement.

O'Keeffe et al (2013) also used a multiple baseline design, in this case to investigate the impact of follow up fluency training on fidelity in the context of a Corrective Reading: Decoding intervention (Engelmann et al, 1999). During this training participants were given extensive opportunities to practise and develop their fluency in three key areas of the intervention: providing opportunities for learners to respond, delivering praise, and giving appropriate corrective feedback.

Overall, the impact of fluency training on the three measures of intervention fidelity showed a positive trend, with participants showing improvements on all three measures. However, while fluency training was found to have a positive impact across the three fidelity measures in the majority of participants, only some participants' fluency consistently reached the

desired fidelity criteria identified by the researchers. It is important to note that the study identified target standards of fluency to be achieved during training that were greater than or equal to targets for fidelity after training. However, these were not consistently met by all participants during training. It seems therefore that while the training delivered had a generally positive impact it was insufficient to support all participants to reach the target levels of fluency. This failure to reach criterion intervention fidelity may in part be due to trainees not meeting fluency goals during training and may suggest that more extensive opportunities for training or more effective training is required to produce high levels of fidelity.

The findings of these studies suggest that training in how to deliver an intervention is crucial to doing so with fidelity and that setting criteria for fidelity and fluency in delivering the intervention may improve intervention fidelity. However, while setting a fidelity criterion in training may have a positive impact on fidelity of delivery the training methods employed, behavioural skills training and fluency training did not support all participants to reach high levels of fluency in the time allowed.

1.3.2.2.2 Ongoing support

While training is clearly important in facilitating the faithful delivery of literacy interventions, the inconsistent findings above suggest that it may not be sufficient in and of itself. Another possible method of supporting educational staff to faithfully deliver literacy interventions is providing them with ongoing monitoring support. In examining the impact of ongoing support Zoder-Martell et al (2013) considered the impact of regular feedback, Vernon-Feagans et al (2015) compared the impact of face to face to web-based coaching on fidelity, and Stein et al. (2008) investigated how additional systemic support can affect fidelity.

Stein et al. (2008) made use of a randomised controlled trial to investigate the impact of ongoing support on the faithful delivery of a KPALS peer mediated literacy intervention (Fuchs et al, 2001) by 224 Elementary school teachers. The study provided three different levels of support for teachers. In the first, teachers received initial day-long training only in the intervention. In the second, teachers received two follow-up booster sessions in addition to initial training to review the intervention, identify issues, and problem solve. In the third condition, teachers received initial training, two booster sessions and weekly technical assistance from an intervention helper in delivering the intervention. Level of support was found to be significantly related to fidelity of intervention delivery, with participants who received both the booster workshop and ongoing delivery support from a helper demonstrating the highest levels of fidelity, and participants who received the additional booster workshops having slightly lower levels of fidelity but still outperforming those who only received initial training in fidelity measures. These effects of

booster workshop and delivery support were maintained even when the effect of site, number of years delivering the intervention and teacher perceptions of support from their setting were controlled for.

In Zoder-Martell et al's 2013 study, a multiple baseline investigation was used to explore the impact of feedback, both verbal and graphed, on the fidelity of delivery by teachers of the Repeated Reading (Samuels, 1979) and the Listening Passage Preview literacy (Rose & Sherry, 1984) interventions. Teachers received initial training and their delivery of the literacy intervention was monitored during the pre-intervention phase, prior to implementation of the feedback aimed at supporting fidelity. Then the intervention, in which participants received either feedback in graphical form alone or graphical feedback accompanied by verbal feedback, was delivered, with two participants receiving the dual feedback condition first and then the graphical feedback alone condition whilst the order was reversed for the other two participants. The study found that feedback, both graphical alone and graphical and verbal together, led to slight improvements in intervention fidelity, either in increasing the level of fidelity or increasing the consistency of fidelity with which the intervention was delivered. While increases following introduction of feedback were generally small, this may be because baseline fidelity was generally quite high - between 60% to 100% fidelity was observed across participants. Following the introduction of feedback, all participants were able to achieve 100% fidelity on multiple occasions. Generally, there was little difference in fidelity between the dual feedback and graphical feedback only conditions, though three participants did show a slight decrease in fidelity of delivery following the shift from the first to second feedback condition. It may be, therefore, that consistence in how feedback is delivered is more beneficial to fidelity than a particular mode of feedback delivery.

In a step beyond simple feedback on intervention delivery, Vernon-Feagans et al. (2015) investigated the impact of coaching on supporting fidelity within the context of The Targeted Reading intervention (Vernon-Feagans et al, 2009). Using data from a randomised controlled trial on the impact of the intervention, they compared fidelity of intervention delivered by teachers who received coaching face to face to those who received it by webcam. The medium in which coaching was delivered was found to be significantly related to the fidelity of intervention delivery, based on observers' ratings of the degree to which delivery of the intervention aligned with core components of the intervention design. Web based coaching was found to be related to higher levels of intervention fidelity than coaching delivered face to face. It should be noted that the researchers noted that web-based coaching was delivered with greater efficiency and focus and was less likely to be interrupted by non-relevant conversations than in person coaching. It may be therefore that webcam coaching led to a more positive impact on fidelity because it was

delivered more efficiently and made best use of the available time. Unfortunately, this study does not provide us with comparison to a no coaching condition, so it is not clear to what degree coaching improves fidelity in comparison to a baseline when no additional support is provided.

The findings of the reviewed studies suggest that additional support following training can be a helpful approach in promoting intervention fidelity in literacy interventions. Both isolated support sessions and ongoing implementation assistance have been found to have a positive impact on fidelity as has feedback - verbal and graphical - from an external individual observing the implementation. Coaching may also prove a useful approach to support fidelity and there is some evidence to suggest that web-based coaching might be more effective than in person coaching, however the overall impact of coaching is not yet clear and further research with a non-coaching control would be required to isolate any positive effects.

1.3.2.2.3 Self-Monitoring

While approaches that rely on support from others either through training or ongoing support may be helpful in ensuring the faithful delivery of literacy interventions, they rely on the availability of external resources, namely the presence and time of suitably trained staff. At a time when resources in schools are particularly stretched it is important to consider methods of supporting fidelity that do not make additional demands on settings. One possible alternative is for staff delivering the intervention to develop the skills to monitor their own delivery of the intervention. Browder et al(2007) and Roberts and Leko (2013) have both investigated whether the use of a task analysis to support intervention deliverers to self-monitor their delivery of literacy interventions can have a positive impact on fidelity.

Browder et al (2007) developed a literacy support intervention in which grade appropriate texts were adapted and used within a structured lesson format to develop the literacy skills of children with moderate to severe learning difficulties. Three teachers received initial training and then, following a period of intervention delivery, were trained to use a task analysis, in which the 25 steps of each literacy lesson were laid out, to monitor their delivery of the intervention. This self-monitoring was found to be successful in supporting the faithful delivery of the literacy intervention, with all three teachers showing an improvement following the introduction of the task analysis and, within three sessions of delivering the intervention alongside the task analysis, delivering all 25 steps of each intervention session consistently.

These initial positive findings were replicated in 2013 by Robert and Leko. In this study, three teachers were trained to deliver a structured literacy intervention, supported by adapted grade appropriate texts, to develop the functional and academic literacy skills of students with

moderate to severe learning difficulties. While individual intervention lessons were bespoke to students based upon the text employed, targets identified were seven core elements common to each lesson and each student. Following training, teachers delivered the intervention making use of a traditionally structured lesson plan to support their delivery and then received additional training on making use of a task analysis to monitor how they delivered the intervention. While teachers were able to deliver approximately 70% of the intervention steps making use of the traditional Lesson plan their fidelity increased following the introduction of the task analysis approach and all three teachers were then able to deliver the intervention with 100% fidelity.

The findings of these studies on the impact of self-monitoring on intervention fidelity through the use of task analysis are encouraging and suggest that this method can prove a useful approach in supporting literacy intervention fidelity.

1.3.3 Strength of the literature

1.3.3.1 Factors contributing to intervention fidelity

While several studies have sought to explore factors which might impact the degree to which literacy interventions are implemented with fidelity there are several overarching flaws in this body of research which suggest their findings should be interpreted with caution. Quality assessment indicated that in the qualitative studies, while the selection of methodology and identifying clear aims of the research were strengths the communication of the methods employed was less successful. In the two studies which made use of semi structured interviews (Main et al, 2020; McIntyre et al, 2005) there was a lack of detail as to procedures used. Moreover, in all three qualitative studies (Main et al, 2020; McIntyre et al, 2005; Daniel & lemons, 2018) there was a lack of detail regarding ethical considerations and the relationship between researchers and participants. Zvoch (2009) was found to be more rigorous, though, as with other studies reviewed, there was a lack of follow up. (For a complete outline of the results for the quality assurance process please see Appendix E).

Both McIntyre et al (2005) and Main et al (2020) reported findings from semi structured interviews relating to factors which impacted fidelity. However, neither paper supplied a methodological outline either of the interview protocol employed or of the approach used to analyse responses. While bias may be impossible to eliminate entirely from qualitative research, without a clear outline of the tools and approaches used by researchers it is impossible to evaluate the degree to which the interview structures employed and the focus of qualitative analysis may have affected participant responses or the interpretation thereof, and therefore the findings of these papers must be treated with caution.

In addition to the methodological flaws in this body of research there is a lack of replication. A possible exception to this might be made for the factor of ongoing support in schools, however it should be noted that the findings in one study related to general support whereas in another specific mention was made of mentoring and coaching, an integral part of the specific intervention considered in this study. This lack of replication should lead us to be hesitant to draw conclusions about the role of these factors in fidelity of literacy interventions in general. These factors might have been important in the individual studies discussed, but they might also relate to the specific circumstances of the study, for example the intervention under investigation.

Overall, these four papers provide us with an interesting starting point for understanding the factors which may impact implementation fidelity in literacy interventions. However, their findings are certainly not conclusive, and they must be replicated by studies with rigorous reporting of methodological approaches before any firm reliance may be placed upon their findings.

1.3.3.2 Approaches to fidelity maintenance

Quality assessment using the quality indicators outlined in Reichow et al (2008) indicated that all of the studies investigating approaches to maintaining fidelity, both group comparisons and single subject designs, were of adequate strength (Table 3). All of the studies reviewed showed evidence of Reichow et al's primary quality indicators. Information regarding the intervention being implemented and characteristics of those delivering it were consistently provided. Dependent variables were relevant, clearly outlined, and measured on an appropriate time scale. In the single study designs baseline conditions were clearly outlined, found to be stable over time, and visual analysis of the multiple baseline graphs indicated an experimental impact for multiple participants. For the two group comparison studies participants were appropriately allocated to groups and suitable statistical analysis was selected and carried out.

What prevented studies from being classified as strong was the lack of consistent demonstration of Reichow et al's (2008) secondary quality indicators. While the majority of studies calculated interrater agreement on observations of fidelity the reliability of measures over time was not reported. Moreover, when fidelity was measured through observation the observer was not blind to the treatment condition, or phase. While some studies made use of follow up measures of fidelity there were rarely long term follow up investigations. Finally, while some social validity indicators were consistently present, the dependent variables were socially important and interventions generally cost-effective, others were not. For example, consumer satisfaction was rarely reported and the approaches to supporting fidelity were delivered by

academics and researchers rather than people with an ongoing role in an educational setting. (A complete breakdown of the quality assessment scores is provided in Appendix F)

Table 3 *Study strength*

Study	Study type	Fidelity intervention	Study report strength
Davenport, Alber-Morgan and Konrad (2019)	Single subject study	Behaviour skills training	Adequate
O'keeffe, Slocum and Magnusson (2013)	Single subject study	Follow up fluency training	Adequate
Zoder-Martell et al (2013)	Single subject study	Verbal feedback Verbal and graphed feedback	Adequate
Vernon-Feagans, Bratsch- Hines, Varghese, Bean and Hedrick (2015)	Group experimental design	Coaching – Face to face Coaching – web based	Adequate
Stein, Berends, Fuchs, McMaster and Saenz (2008)	Group experimental design	Training Training & booster workshop Training, booster workshop & delivery assistance	Adequate
Browder, Trela and Jimenez (2007)	Single subject study	Self-monitoring using a task analysis	Adequate
Roberts and Leko (2013)	Single subject study	Self-monitoring using a task analysis	Adequate

Reichow et al (2008) also set out criteria by which interventions can be considered to be evidence-based practice. According to these criteria, to be considered promising evidence-based practice an intervention must have at least three single subject studies of at least adequate research report strength conducted by two different teams in two different locations with at least nine participants, or two group experimental designs of at least adequate research report strength. In this review the approaches designed to support fidelity were treated as fidelity interventions and this criteria was employed to evaluate whether the extant research met the criteria for any of these approaches to be treated as evidence based practice.

As can be seen in Table 3, for the majority of interventions designed to support fidelity of intervention delivery, only one study - either group or individual participant based - has been conducted. For the use of a task analysis to support fidelity of intervention delivery through self-monitoring two single subject studies of adequate report strength have been completed. Therefore, none of the interventions designed to support fidelity in literacy intervention delivery reach the criteria to be considered evidence-based practice.

Moreover, there are several consistent shortcomings in this body of research which means we must be cautious in interpreting it. As noted above, the studies reviewed employed an approach in which fidelity was measured through observation prior to, during and after intervention. In all of the studies reviewed the observers, both primary and secondary, were aware of the stage of the intervention process or group that the participant was in and whether or not the intervention had been delivered. It is therefore possible that the expectation of a positive effect from the intervention may have had an impact on the fidelity ratings provided by observers. While steps were taken in the majority of studies to ensure observer accuracy through the calculation of inter-observer agreement this step may have had limited efficacy when both observers were aware of whether the intervention had been delivered or not.

In the majority of studies outlined in this review fidelity was measured by researchers observing, either in person or through video recordings the delivery of the intervention. In many cases not only was the observer present but they were the person who had delivered the training or the intervention. It seems likely that the presence of an observer evaluating intervention delivery, particularly when that observer had delivered training or was delivering feedback, may have had an impact on the degree of fidelity with which the intervention was delivered. Participants may have been more likely to deliver the intervention as outlined in initial training or suggested through feedback and coaching when the observer was present to observe them. Therefore, while many studies attribute a causal effect to the intervention designed to support fidelity of delivery, without a measure of fidelity that does not involve the presence of an

observer we cannot rule out that the presence of an observer may itself have led to higher levels of fidelity.

1.4 Discussion

1.4.1 Summary and overview

The aim of the current review was to develop an understanding of the factors which may play a role in delivering literacy interventions with fidelity. While the quality of the literature to date does not allow for conclusive conclusions to be drawn it does provide some suggestions on factors which may play a role in fidelity and approaches which might be of use to promote it.

In terms of factors relating to the faithful implementation of literacy interventions, there is evidence to suggest that the context within which the intervention is delivered, the characteristics of the individual delivering it, and the features of the intervention itself may play a role in faithful delivery. The number of students in this setting, both school and classroom, in which the intervention is delivered may play a role in how faithfully the intervention can be delivered, with fidelity to intervention appearing reduced in larger settings. This finding relating to the impact of environment is consistent with existing research relating to 'Nudge Theory'. This theory states that people are more likely to make healthy or adaptive choices when the environment encourages them to do so (Arno & Thomas, 2016). It seems that, in accordance with this theory, intervention deliverers may be more likely to make faithful choices in environments with fewer competing demands.

Furthermore, the skills and level of education of the interventionist can impact fidelity and interventionists may need time in order to develop their ability to deliver interventions faithfully. Interestingly, high levels of education may not support faithful delivery of interventions, as might have been expected. Though this finding arises from a single, un-replicated study, all be it one with a moderately large sample, it does seem to agree with the findings of Rohrbach, Graham, and Hansen (1993) who found that more experienced teachers were less likely to implement a drug prevention teaching program.

Additionally, there also seems to be a variation in fidelity related to the intervention programme itself. However, there has not been research to date exploring what intervention factors might be impacting fidelity and further investigation into the impact of intervention components on fidelity is required.

While the context, deliverer and the intervention itself may play a role in supporting and undermining fidelity, there are also a range of approaches which might support the faithful

delivery of literacy interventions. In agreement with existing research on the importance of teacher training to programme fidelity (Hanley et al, 2009) training was found to have a positive impact on fidelity and, particularly, providing a fidelity criterion which interventionists must reach during training has been suggested to promote faithful delivery thereafter. However, the findings relating to the impact of setting a fidelity criterion are not yet conclusive and further investigation will be required to ascertain whether this approach to training will lead to consistent meaningful gains.

Organisational support has been previously found to be positively associated with curriculum fidelity. These findings were supported by the studies reviewed suggesting that ongoing support following training can promote fidelity in literacy intervention delivery, with supported problem solving, delivery assistance, feedback and coaching having been shown to lead to gains and fidelity in small samples. While, again, further research will be needed to support these preliminary findings, they do suggest that providing external support in delivering the intervention may increase the degree of fidelity with which it is delivered. There is also a role for those delivering the intervention to play in supporting fidelity, and the findings suggest that self-monitoring using a structured tool, for example a task analysis, may be a useful and efficient approach in ensuring high levels of intervention fidelity. Previous research suggests that such tools might support fidelity by increasing the level of accountability that those delivering the intervention experience (Givens, Francis, Wilson, Parisi, Phillips, & Villodas, 2020).

Regarding the identified research question ‘what are the factors which impact the fidelity with which literacy interventions are delivered in schools?’ the current study was able to identify several systemic factors which might impact fidelity as well as a range of approaches which can be used to support it. However, limitations of the available research mean that definitive conclusions cannot yet be drawn as to the impact on fidelity of the factors identified. Moreover, there may be factors which impact fidelity not identified in this review due to limitations of the research available. One example relates to components of the intervention itself. While Zvoch’s (2009) findings suggest that different interventions may vary regarding the degree of fidelity with which they are implemented the literature does not yet explorer what within intervention factors may lead to this variation infidelity. Therefore, in order to more conclusively answer the identified research question it will be important for future research to replicate and expand the findings in this field.

1.4.2 Implications for future research

The greatest weakness in this body of literature is the lack of replication. Only one study sought to replicate previous findings related to the role of fidelity maintenance approaches and supporting intervention fidelity. Additionally, the studies that have been conducted often relied on small sample sizes. While several of the findings outlined above are encouraging, especially related to the positive impact of self-monitoring and ongoing support strategies, none reach the criterion to allow us to consider any approach to fidelity maintenance as evidence-based practice. Additional research is needed to replicate these initial results, and at a high enough standard to validate the widescale adoption of these approaches. Furthermore, the majority of studies reviewed were conducted in the United States, with one taking place in Australia: replication of this research in the United Kingdom is necessary to ensure the validity of these approaches to supporting fidelity in a local educational context.

Moreover, while the research has highlighted certain implementation factors that may play a role in intervention fidelity there have been certain pervasive methodological shortcomings that undermine the confidence that can be placed in current findings. Future research must seek to use high quality and rigorous methodological and analytical approaches to provide a comprehensive understanding of implementation factors. Steps must also be taken to ensure that the approaches used are transparent and communicated in such a way as to ensure that studies can be replicated.

While the evidence suggests that factors related to the intervention may impact the fidelity with which it is delivered, and past research related to training implementation may support this (Burke & Hutchinson, 2007), there have, to date, been no findings specifically related to what specific intervention characteristics might undermine or support fidelity in literacy interventions. A further route for research, then, might be to compare fidelity across multiple interventions and to explore varying characteristics and the role that these might play in faithful literacy intervention delivery.

1.4.3 Implications for practice

While the literature has not yet reached the level to provide us with a comprehensive understanding of factors impacting fidelity or approaches to support it, the current review provides some implications for practice for educational professionals. First, educational professionals implementing literacy interventions need to give careful consideration to the context within which they deliver the intervention and the individuals who are going to deliver it. Contextual factors were particularly highlighted in the research and suggest that considerable

pre-planning will be necessary to faithfully deliver interventions, and it will be important to ensure that intervention deliverers have planning time and ongoing support, as well as opportunities to practise and develop their confidence and skills with the intervention. Additionally, it is important to consider differing structural contexts of schools and classrooms. In larger schools and classrooms, it may be necessary to provide higher levels of support to ensure high intervention fidelity from the beginning of intervention implementation. It will also be important for settings to consider who is delivering interventions to be aware of the impact that those individuals' skills and level of education may have on their faithful delivery of the intervention. It may therefore be necessary for settings to provide bespoke support designed to best meet the needs of individual interventions rather than providing a 'one size fits all' approach in supporting interventionists.

Training has been shown to be important in delivering interventions with fidelity and, while the evidence is not yet conclusive, the research suggests that including a criterion for fidelity during delivery practise in training may support faithful delivery moving forwards. While there is often a pressure, particularly in services where educational psychology services are traded, to deliver intervention training in short amounts of time, the findings of this study suggest that more comprehensive and perhaps extended training may support fidelity. It may be helpful for educational psychologists to consider including targets for interventionists to meet during training, or in practise within the educational setting following on from training, before they are encouraged to deliver the intervention independently.

Following on from training the research suggests that ongoing support may be helpful to support faithful delivery of the intervention. This could be provided through observation, feedback, coaching or problem-solving supervision. While there is clearly a role for educational psychologists in participating in an ongoing auditing process of literacy interventions being delivered in schools they work in, it may also be possible for them to train members of staff to act as intervention leaders, whose role will be to ensure fidelity, and give these members of staff the skills necessary to support interventionists in faithful delivery. Ongoing support from a trained intervention assistant may also be an effective method of supporting intervention fidelity. However, this represents a significant expenditure of resources. When possible, this approach could be used by professionals to support intervention fidelity, however other methods of ongoing support may provide slightly less effective but significantly less resource intensive methods of supporting fidelity.

Self-monitoring alone was shown within these studies to be effective in supporting intervention fidelity, and as a relatively resource-light method of supporting fidelity it could be

adopted both by educational settings and incorporated into training by educational psychologists. However, it should be noted that the majority of the research reviewed measured fidelity using observational tools. Therefore, while participants were able to use a task analysis to deliver interventions with high degrees of fidelity they did so while being observed, often by the primary researcher, which may have also had a role in promoting fidelity. It may, therefore, be useful to incorporate multiple approaches, for example ongoing self-monitoring along with intermittent outside support in the form of observation and feedback, coaching or problem-solving sessions.

Finally, as stated, the evidence regarding the positive impact of these approaches to maintain fidelity, and more generally the factors relating to fidelity, is not conclusive. Therefore, it will be important for educational professionals and settings to engage in an ongoing review process of whatever measures they implement to support fidelity. Carefully monitoring the fidelity with which literacy interventions are delivered and seeking feedback from those involved as to the impact of fidelity support mechanisms.

1.4.4 Strengths and limitations

Fidelity to intervention is an emerging area of interest within the literature of literacy intervention research which has grown over the last two decades due to a rising emphasis on evidence-based practice and teacher accountability. While interest in this area seems to be on the rise this is the first review to seek to gain a comprehensive understanding of factors affecting intervention fidelity in literacy interventions. It therefore plays an important role in highlighting the strengths and limitations of the research in this field. The systematic nature of this review provides not only a replicable procedure for future investigations but also provides confidence in its findings in this area. Importantly, it highlights the need for replication and further systematic research in this field.

While this review provides a promising start in examining factors which may contribute to intervention fidelity in literacy interventions the as yet limited scope of the research available means that its findings should be interpreted cautiously. As of yet there is limited replication of any of the findings detailed herein and many of the studies outlined rely on small samples. Moreover, the lack of studies investigating the impact of fidelity factors and approaches over time means their role in fidelity in literacy interventions in the long term is not yet clear. As the literature in this field grows it will be important to repeat this systematic review process in order to gain a clearer and more comprehensive understanding of the role that these factors play in fidelity in literacy interventions and how best to support intervention fidelity moving forwards.

Moreover, this review has a key weakness which may undermine its applicability in the United Kingdom. The majority of studies reviewed took place in the United States, with one in Australia. While these countries represent a western cultural context and their findings may therefore be generalisable to the United Kingdom there are key differences between these locations. For example, the cultural demographics of the United Kingdom, Australia, and The United States should be considered. Moreover, the structure of the American and Australian education systems may differ enough from those in the United Kingdom that the findings may not directly transfer to this context. In future it will be important to replicate these studies within a local, ecologically valid context but until that takes place further caution should be taken when seeking to apply the findings of this review in the United Kingdom.

1.4.5 Conclusion

To conclude, the research related to contributing factors to intervention fidelity is still emerging but encouraging. It highlights the need to consider contextual factors when implementing a literacy intervention and also provides some useful suggestions relating to approaches that can support faithful delivery of literacy interventions. While there are some methodological shortcomings related to this body of literature and, as of yet, a lack of replication, it is important to note that this field is relatively new with all studies reviewed having been published in the last fifteen years. Moving forwards, it will be important to ensure that future research is conducted to a high methodological standard to ensure confidence in its findings and implications and also to ensure that enough replication is taking place to allow us to firmly establish evidence-based-practice in this field. However, even given the shortcomings outlined, the current review provides a positive foundation on which future research in this area can build.

Chapter 2 An investigation into the factors contributing to fidelity in precision teaching interventions.

2.1 Introduction

In order to master a taught skill a learner must reach the stage of fluency, in which they can use it swiftly and accurately (Haring, Lovitt, Eaton & Hanses, 1978). Gallagher, Bones and Lombe (2006) suggest that underachievement in learning arises from the cumulative effect of a consistent lack of success in achieving fluency in core learning skills. Precision teaching (PT) is an instructional method first developed in the United States in the 1960s based on behaviourist principles, particularly on Skinner's work on behavioural fluency (Apler & White, 1971; Lindsley, 1992; Lindsley, 1991; Potts, Eshleman & Cooper, 1993). The aim of PT is to closely monitor children's progress in learning by measuring the fluency with which they are able to demonstrate a skill (Lindsley, 1991). Instructors and learners are then able to use these measures of progress to (Lambe, Murphy & Kelly, 2015; Potts, Eshleman & Cooper, 1993). PT can therefore be combined with a range of instructional approaches to provide a bespoke and effective educational tool for individual learners (Lindsley, 1991). Through enabling learners to reach fluency in a new skill, the approach aims to support the generalisation and application of the skill beyond the intervention (Lambe et al, 2015; Haring et al, 1978).

A PT intervention is designed to be implemented in brief daily sessions (Lindsley, 1992). Solity and F (1987) outline the four stages of each session. Each begins with a short teaching activity, using an instructional approach selected by the teacher rather than mandated by the intervention. The student's behavioural fluency is then measured using a test which assesses how many correct responses the learner can give in one minute. These tests are always delivered consistently using a probe grid (See Appendix G). The learner is presented with a series of heard or seen items to which they must provide a verbal or written response. The instructor scores each response and the number of correct and incorrect responses given in one minute are recorded. In the third stage of each PT session the learner charts the number of correct and incorrect responses that they have given that day on a 'celeration' chart (see Appendix G). Finally, the teacher and learner review the progress that is being made. If the learner is on track to meet their targets for the number of correct and incorrect responses, then the method of instruction is retained. If not, another is trialled.

There are several core components considered crucial to a PT intervention as it is outlined in Lindsley's original programme design:

1. Prior to the start of the intervention success criteria must be set to ensure that the learner has reached fluency in the target skill. These include a minimum number of correct responses in one minute and a maximum number of allowable errors (Lambe et al, 2015).
2. The learner is responsible for recording the number of correct and incorrect responses and tracking them visually on the celeration chart (Lindsley, 1991; Potts, Eshleman & Cooper, 1993). (It should be noted that this component of the intervention may not reflect current practice, for Example Roberts and Norwich (2010), outline scoring and charting alongside the learner and not specifically by them)
3. The use of a celeration chart (Lindsley, 1991). This is a logarithmic chart (Lambe et al, 2015) on which the number of correct and incorrect responses are recorded daily to provide a two line visual representation of the progress that the learner has made (Potts, Eshleman & Cooper, 1993). The steeper the gradient of the two lines the greater the acceleration in behavioural fluency.
4. Using the visual representation of progress to inform data driven decisions regarding the instructional method employed (Lindsley, 1992; Potts, Eshleman & Cooper, 1993). If the learner is not on track to meet their pre-set targets within a specified time frame, then the instructional method is either discarded or adjusted until a more effective approach is identified.

While historically there has been a great deal of research on the impact of PT from the United States (Boys & Lyndon, 2008), there is now a growing evidence base for the intervention in the UK and Ireland. Lambe et al (2015), Griffin and Murtagh (2015), Roberts and Norwich (2010) and Downer (2007) found that PT interventions led to improvements in word reading fluency. Improvements were maintained at follow up testing three weeks after the intervention (Lambe et al, 2015) and three months (Roberts & Norwich, 2010) later. Beyond its utility in supporting the development of literacy skills, PT interventions have also been shown to have a positive impact on children's math skills (Chiesa & Robertson, 2000) as well as improving children's academic self-concept (Roberts & Norwich, 2010).

Unfortunately, not all studies on the impact of PT are of a high methodological standard, with some relying on relatively small samples and failing to compare gains following PT intervention to any control condition (Lambe et al, 2015; Downer, 2007). Despite these shortcomings, the weight of evidence seems to suggest that PT can have a positive impact in a range of areas. Ramey, Lydon, Healy, McCoy, Holloway and Mulhern (2016) evaluated the methodological rigour of 55 studies exploring the impact of PT in populations of children with learning difficulties. Employing the National Autism Centre's National Standards Report they concluded that there was emerging

evidence for the positive impact of PT interventions across several curriculum areas - Literacy, numeracy and Vocational skills- as well as on key early developmental skills including play, labelling emotions and speech articulation.

Findings on the positive impact of PT are encouraging, but there is also evidence to suggest that there are barriers which can undermine its delivery. For example, at one month post-delivery of training on PT Daly and Cooper (1993) found that only 30 out of 48 trained teachers had actually delivered the intervention. Sundhu and Kittles (2016) investigated factors that might be undermining the implementation of PT interventions and found limited time, poor attitudes toward PT and high turnover of staff to be the main obstacles. Raybould and Solity (1988) highlight that many teachers are doubtful about the theoretical underpinnings or practical delivery of PT and that these concerns may prevent them making use of it.

Even when PT interventions are implemented following training they may not be delivered effectively. Raybould and Solity (1988) highlight that two of the key difficulties with disseminating PT as an intervention are “partial digestion,” where trainees do not understand the intervention well enough to be able to successfully apply it in novel situations, and “faulty transmission,” where information about the intervention is passed on imperfectly leaving those delivering it with a flawed understanding that may lead to incorrect delivery. Of the 30 teachers that delivered the intervention in Daly and Cooper’s (1993) study, only 16 did so faithfully while the other 14 stopped using the celeration chart identified as a core component of the intervention (Lindsley, 1991 &1992; Solity and Bull, 1987). This lack of fidelity to the PT intervention seems to have been an issue even in the early days of its use. In 1988 Starlin investigated the use of celeration charts by schools delivering PT. In seven out of 15 schools celeration charts were not being implemented at all and in seven of the eight remaining they were only used intermittently. Out of fifteen schools only one was consistently using celeration charts as part of their PT intervention.

As Webster, Russell and Blatchford (2015) point out, the effectiveness of an intervention may only be predictable when it is delivered with a high degree of fidelity to the intervention program. There is evidence to suggest that adaptions made to the delivery of PT interventions may affect their outcomes. In Roberts and Norwich’s (2010) study a PT intervention targeting word reading was delivered to two cohorts of secondary school students. During the intervention for the second cohort a framework was provided to implementers based on observed good practice from the first cohort. While the gains in word reading made by the two cohorts were not statistically compared, greater gains were made by the second cohort, for which implementers made use of the good practice framework. Roberts and Norwich suggest that the difference in impact of the

intervention on cohorts one and two was due to the differences in the quality of the learning experience that they received.

It is important to consider how a PT intervention is delivered and the broader implications of its delivery within the context of special needs education within the UK. The first aspect to consider is who is delivering PT interventions. While PT was first designed to be delivered by qualified teachers as a whole class approach (Lindsley, 1992), in the UK it is often delivered by teaching assistants (TAs) as a one to one intervention (Downer, 2007). The Education Endowment Foundation Teaching and Learning Toolkit (Higgns et al, 2018) classifies TAs as a high cost moderate impact method of educational support. However, Webster et al (2016) point out that one area in which TAs may have a positive impact on the learning of children with special educational needs (SEN) is through the delivery of high quality, evidence based interventions and supporting the generalisation of taught skills back to the classroom. Therefore, delivering a PT intervention may be an effective way for TAs to work with students. On the other hand, Webster et al (2016) highlighted that children with SEN often have more contact time with TAs than they do with their teachers. They argue that this limited interaction with teachers has a negative impact on children's learning. It may be that delivering a PT intervention might allow teachers to engage directly with their more vulnerable students in a way that will maximise learning progress.

Whether the PT intervention is implemented by teachers or TAs, it is vital it is delivered with a high degree of fidelity. Given that, according to Webster et al (2016), children with SEN are likely to have limited contact time with their teachers it is important that when they do receive direct teaching time that it is used to the best effect. Evidence based interventions provide an opportunity to maximise the impact of TAs (Webster et al, 2016) but how the intervention is delivered may impact its effectiveness (Roberts and Norwich, 2010). If PT is not delivered faithfully it may negate the opportunity for both teachers and TAs to have a positive impact on the learning of children with SEN.

While previous research has explored the barriers to implementing a PT intervention following training there is a lack of research regarding the underlying causes of poor intervention fidelity.

The current study aims to:

1. Identify the barriers to faithfully delivering a PT intervention for teachers.
2. Identify the barriers to faithfully delivering a PT intervention for teaching assistants.

2.2 Method

2.2.1 Participants

Participants were recruited from four schools in two local authorities in the South of England. For initial training 44 participants were recruited: 24 teachers and 20 teaching assistants.

Schools were initially recruited through discussion between the school's link EP or the lead researcher and the SENCo. School staff were then approached by the SENCo, and information sheets regarding the study were distributed. All members of staff who wished to take part were invited to attend training. Participants did not receive any incentive to take part in the research, however, participating schools received the PT training for free.

The original aim was to collect fidelity data for all participants and then interview only those with very high or low fidelity scores. The initial target was to recruit 30 participants to allow for purposive sampling following initial training. This target was exceeded due to a high level of interest among school staff. Due to low numbers of completion of fidelity questionnaires, however, (N=16, males=2) all participants who completed this measure were invited to take part in interviews. It was not possible to interview five of these participants (three teachers, two TAs) due to lockdown measures during the COVID-19 pandemic. In the end, 11 participants – five teachers (males=1) and six teaching assistants (males=0) – completed all three stages of this study, i.e., training, questionnaire, and interview.

2.2.2 Materials

To ensure ecological validity, the training used in this study was based on the package typically employed in the first local authority from which participants were recruited (within the second local authority, no set form of PT training was used). The principle of behavioural fluency was outlined to provide a theoretical context for PT and the training then outlined the key components of a PT intervention, including target setting, recording, visually charting progress using a celeration chart, and the use of data collected to inform teaching strategies. The format of PT outlined in this training followed the four-step process outlined by Solity and Bull (1987): teach, test, track (chart), and review. The training also outlined two rules for deciding whether sufficient progress was being made: the 'three-day rule' and the 'eight-day' rule (Roberts and Norwich, 2010). The three-day rule advises that – if a learner has not made visible progress in three days that either the teaching method or the number of items taught be adjusted. The eight-day rule advises that if the learner is not on track to meet their target at day eight then the teaching method should be adjusted, or an incentive added to increase pupil motivation.

Participants attending training were also given the opportunity to practice all four daily stages of the intervention.

All participants were provided with a PT resource pack in line with local practice. Included in this pack were activities used during the training to practice teaching and testing, and tracking and reviewing progress. The pack also included resources to support the delivery of the intervention following training, including example and blank probe sheets, example celeration charts and templates for recording teaching methods and targets. (For further details of the training employed in this study please see Appendix H).

Since this study aims to understand the barriers to a faithful implementation of PT, it was considered important to gauge participants' understanding of the approach after a period following training delivery (8-12 weeks). This fidelity to the intervention was measured using a bespoke questionnaire based upon the content of the training. The first two questions asked participants how many children they had delivered the intervention to and for how long. There were then 16 multiple choice questions that sought to assess the degree to which the participants' delivery of the intervention accorded with the steps outlined in the training. Questions were included on how the focus of the PT intervention was identified, how aim rates were set, how the daily intervention was structured, and how performance was measured, recorded, and reviewed. For each question, each participant was either scored correct or incorrect and received a mark of one or zero. However, for four questions (6, 8, 17 and 18) there was more than one correct answer: on these questions, participants did not have to circle all of the correct responses, however if they gave an incorrect response they did not receive a mark, even if they also gave a correct response. If responses indicated that a participant had not completed that aspect of the intervention they received a score of zero. The maximum fidelity score a participant could achieve was 16. (For further details of the questionnaire used please see Appendix I).

2.2.3 Design

This study was conducted in accordance with a mixed methods design paradigm and collected both quantitative data, from questionnaires related to the fidelity of intervention delivery, and qualitative data, from participants responses in semi structured interviews, in which the experiences of participants in delivering a PT intervention and the barriers that they encountered to doing so faithfully were explored. It was analysed using reflexive thematic analysis according to the procedure outlined by Braun and Clarke (2006; 2020).

The mixed methods design was chosen based on the researcher's critical realist epistemological stance. According to Ekström (1992), a critical realist seeks to understand the underlying causal factors that contribute to observable events. These factors may arise from within the person acting or be imposed by the social context within which the actor is operating. Critical realism posits that ontology and epistemology are entirely separate and that there is an observable reality that is independent of humans' theoretical understanding of it, however we as observers are not capable of forming an understanding of reality that is free of bias and subjectivity. It highlights that developing theories or causal explanations of observable events through rational observation and judgments can develop our understanding of that reality (Fletcher, 2017). In line with this epistemology, the current study aims to develop an understanding of the mechanisms that lead to a lack of fidelity in PT interventions. These mechanisms may arise due to factors unique to the actor or resulting from the wider social context. To develop this understanding, a reflexive approach to thematic analysis was selected in which the researcher takes an active and interpretive role in generating themes from the data collected (Braun and Clarke, 2020).

2.2.4 Procedure

This research was conducted with ethical approval from the University of Southampton's School of Psychology Ethics Committee (See Appendix N). Once schools and individual participants had been recruited, informed consent from participants was obtained by the primary researcher who then delivered the training (see appendices O &P). In one school, training was delivered during the school day while cover was provided for school staff. In the other three schools, training was delivered after the end of the school day. Schools were asked to guarantee participants the opportunity to deliver the intervention to at least one student as part of agreeing to participate in the study.

Following training, a period was allowed in which participants were asked to deliver the intervention with identified students within their school. In the two schools where interviews were conducted there was an average period of 9 weeks of school term time between training and completion of questionnaires.

At the end of the intervention period, questionnaires were sent to schools to be completed by all participants. The aim of the questionnaire was to identify a maximum variation purposeful sample, in which participants with the highest and lowest fidelity scores would be selected to be interviewed (Palinkas et al, 2015). However, due to a low completion of

questionnaires by participants, this sampling method was discarded. Instead, all participants who completed questionnaires were invited to take part in the interview stage.

Semi-structured interviews were conducted by the primary researcher. In accordance with guidance from Whiting (2008) they were conducted in quiet rooms in the participants' schools and were scheduled in advance. A predetermined interview protocol (See Appendix J) was used to guide the structure of the interview, however an informal conversational style was employed (Longhurst, 2003) and further questions arose from the conversation.

In order to minimise any negative feelings that participants might experience when a lack of fidelity was explored a script was included at the beginning of each questionnaire (see Appendix I) and was repeated at the beginning of each interview. The script highlighted that within the real-world environment of a school it can be difficult to implement an intervention as training dictates. It also identified the key interest of the researcher as being understanding changes that were made and why they were made, and encouraged participants to be open about any adaptions that had occurred during the course of delivering the intervention. Following competition of the interview process Debriefing information sheets were sent to participants (see Appendix Q).

2.2.5 Data Analysis

Descriptive data on the fidelity of the intervention delivery was generated through analysis of the questionnaire responses. The mean fidelity score was calculated for Teachers and TAs and the range of fidelity scores was reported. In order to identify areas of high and low fidelity, questionnaire data was then analysed by question and the proportion of correct responses to each question was reported.

A paid research assistant transcribed the interviews verbatim. All data was stored on password-protected laptops and transferred using the secure data transfer service 'SendSafe'. The primary researcher then reviewed the transcripts while listening to the original interview recordings to ensure accurate transcription. Reflexive thematic analysis, as outlined by Braun and Clarke (2006) was used to analyse the data collected through semi-structured interviews. The stages of analysis (Braun & Clarke, 2006; 2020) and analytic procedures employed by the researcher are outlined in Table 4. The aim of the current study was to identify the factors which might impact fidelity for both teaching assistants and teachers. Due to the differences in role, responsibilities, and training between these two groups it was considered important to ensure

that the analysis allowed for differing barriers to fidelity for teachers and teaching assistants to be identified. Therefore, data collected from teaching assistants and teachers was analysed separately. Coding was carried out using NVivo8 software.

Inductive coding was used in line with the reflexive thematic analysis approach. The analysis sought to generate themes based upon explicit or semantic themes without exploration or interpretation of the implicit underpinnings of what has been explicitly stated (Braun and Clarke, 2016). The aim of the study was to develop a broad understanding of the factors that might undermine fidelity in PT rather than to develop an in-depth understanding of any particular causal factor. Therefore, codes were generated across the data set without a particular focus on one area of participants' responses.

Table 4 *Stages and procedures of thematic analysis*

Stage of analysis	Analytic procedure employed
Familiarising yourself with your data	• The lead researcher listened to each interview record five times. • The lead researcher read each interview transcript twice while listening to the recordings. Any errors in transcription were corrected at this point. • The lead researcher read each transcript again making notes of possible codes.
Generating initial codes	• Each data item in the complete data set was coded by labelling each aspect that the lead researcher had identified as interesting.
Generating initial themes	• All the codes were reviewed and sorted based on underlying

	relationships, first between codes and then between possible themes.
Reviewing themes	• The data extracts included under each theme were read and reviewed to ensure there was a unifying pattern. • In cases where divergent patterns were identified themes separated. • In cases where separate themes were found to have a unifying pattern themes were merged. • The data set was reviewed to ascertain whether the themes identified accurately reflected the data. • The data was recoded to incorporate any omitted data into the identified themes.
Defining and naming themes	• The data within each theme was reviewed and organised into a coherent narrative. • Relationships between themes were identified. • Possible names which summarised the contents of the themes were developed reviewed and refined.

Producing the report	• The narrative of each theme was summarised and illustrative quotes selected.

2.3 Results

2.3.1 Questionnaire

The mean fidelity scores achieved by teachers and TAs on the fidelity questionnaire, along with the lowest and highest scores, are reported in Table 5. It can be seen that, at 8.37 and 8.13 respectively (out of a possible total score of 16), both groups on average only answered a little over half of these questions correctly, indicating that fidelity was quite low for both teachers and TAs when delivering a precision teaching intervention. The number of correct responses given for each question is given in Table 6.

For TAs and teachers the questions with only one correct response for each group related to setting accuracy targets for see/hear to write probes and the length of the teaching session. This indicates that both groups did not correctly set the level of acceptable errors when using a probe that required learners to write their answers. Questionnaire responses indicate that they generally delivered shorter teaching sessions than suggested during training.

Conversely, all TAs responded correctly to the question on how the child's performance was scored, indicating they all scored the number of correct and incorrect responses.

Seven teachers and seven TAs responded correctly to the questions on how they measured the child's fluency and how long the test lasted. This indicates that the majority of teachers and TAs used a probe grid to test learner's accuracy through a one-minute probe.

Table 5 *Mean fidelity scores for teachers and TAs*

	Fidelity Score			
	Mean	Standard Deviation	Lowest	Highest
Teachers	8.37	2.59	4	12
TAs	8.13	1.62	5	10

Table 6 *Fidelity questionnaire correct responses by question*

	Number of correct responses (% of participants)	
	Teachers (N=8)	TAs (N=8)
Q3 How did you decide where to focus your Precision Teaching program? (Correct response: Did a short test to find out what the child knows)	4 (50)	3 (38)
Q4 How many items did you teach at a time? (Correct response: 3-5	5 (63)	3 (38)
Q5 What kind of targets did you set for the child to meet before they could move on to the next teaching items? (Correct response: The maximum incorrect and the threshold correct)	4 (50)	1 (13)
Q6 What aim rates did you use to set targets for see to say probes? (Correct response: 40 items correct for infant pupils and 50 correct for juniors. Or Individual aim rates based on measures of the child's fluency on known items)	4 (50)	7 (88)
Q7 What minimum accuracy markers did you use for see to say probes? (Correct response: 3 errors or less in a minute)	3 (38)	2 (25)
Q8 What aim rates did you use to set targets for see/hear to write probes?	3 (38)	4 (50)

(Correct response: 15 items correct for infant pupils and 30 correct for juniors. Or Individual aim rates based on measures of the child's fluency on known items)		
Q9 What minimum accuracy markers did you use for see/hear to write probes?	1 (13)	1 (13)
(Correct response: Errors up to 10% of the fluency rate)		
Q10 How long did you spend on the teaching section of the session?	1 (13)	1 (13)
(Correct response: 6-8 minutes)		
Q11 What kind of teaching activity did you use?	6 (75)	6 (75)
(Correct response: A quick activity that gave the child feedback on each response)		
Q12 How did you test the child's fluency?	7 (88)	7 (88)
(Correct response: Using a probe grid)		
Q13 How long did your test last?	7 (88)	7 (88)
(Correct response: 1 minute)		
Q14 How did you score the child's performance?	6 (75)	8 (100)
(Correct response: Counted the number of correct and incorrect responses)		
Q15 How did you record the child's performance?	4 (50)	4 (50)
(Correct response: On the celeration chart used in training)		
Q16 When did you move on to a new set of teaching items? (Correct response: Once the child had met their target three times in a row)	5 (63)	5 (63)
Q17 If the child had not made progress in three days what did you do?	5 (63)	4 (50)

(Correct response: Change the number of items you taught. Or Change the teaching method. Or Choose easier teaching items)		
Q18 If the child did not hit their target in eight days what would you do?	2 (25)	2 (25)
(Correct response: Change the teaching method. Or Add a motivating reward)		

2.3.2 Thematic Analysis

Thematic analysis generated three themes each for teachers and TAs. While the three overarching themes were identical for teachers and TAs several sub-themes differed between groups. Each theme will be explored separately for teachers and TAs. Themes are not reported in any hierarchical structure and the order of reporting does not reflect varying levels of importance. The themes generated are presented in the thematic maps in figures 3 & 4.

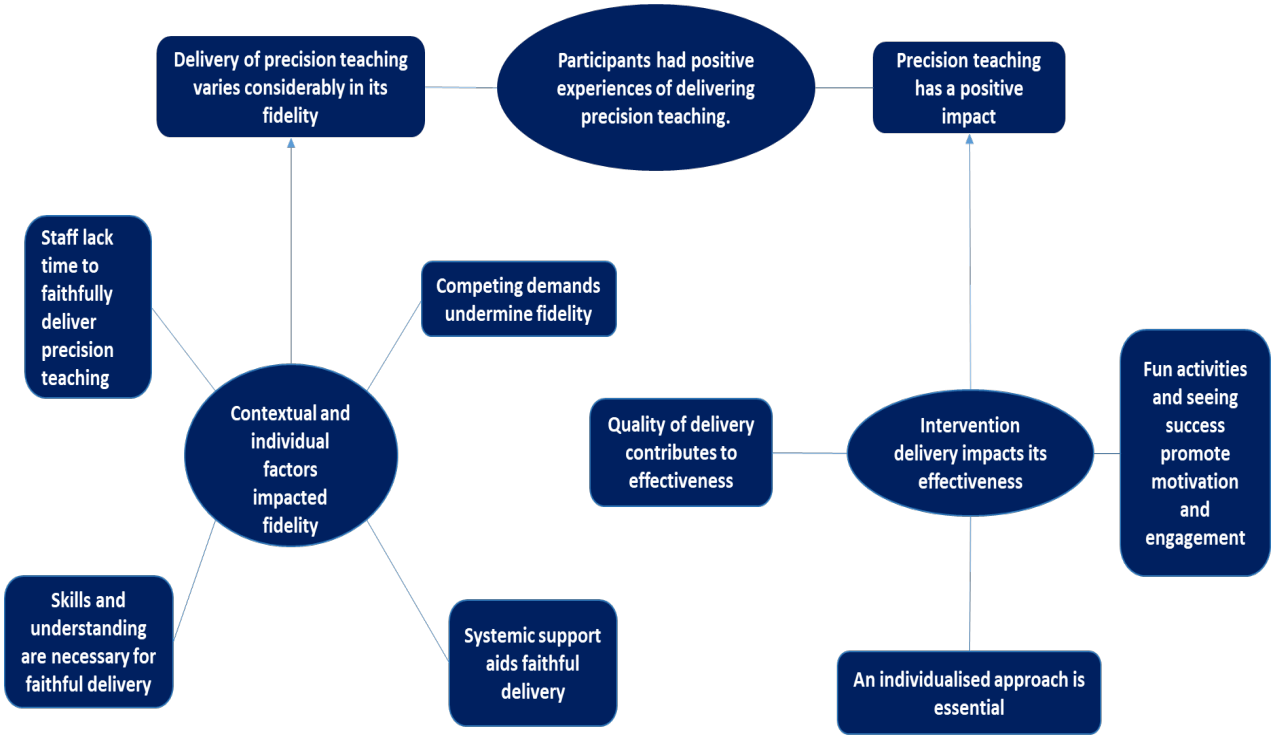


Figure 3 Thematic Map for Teachers

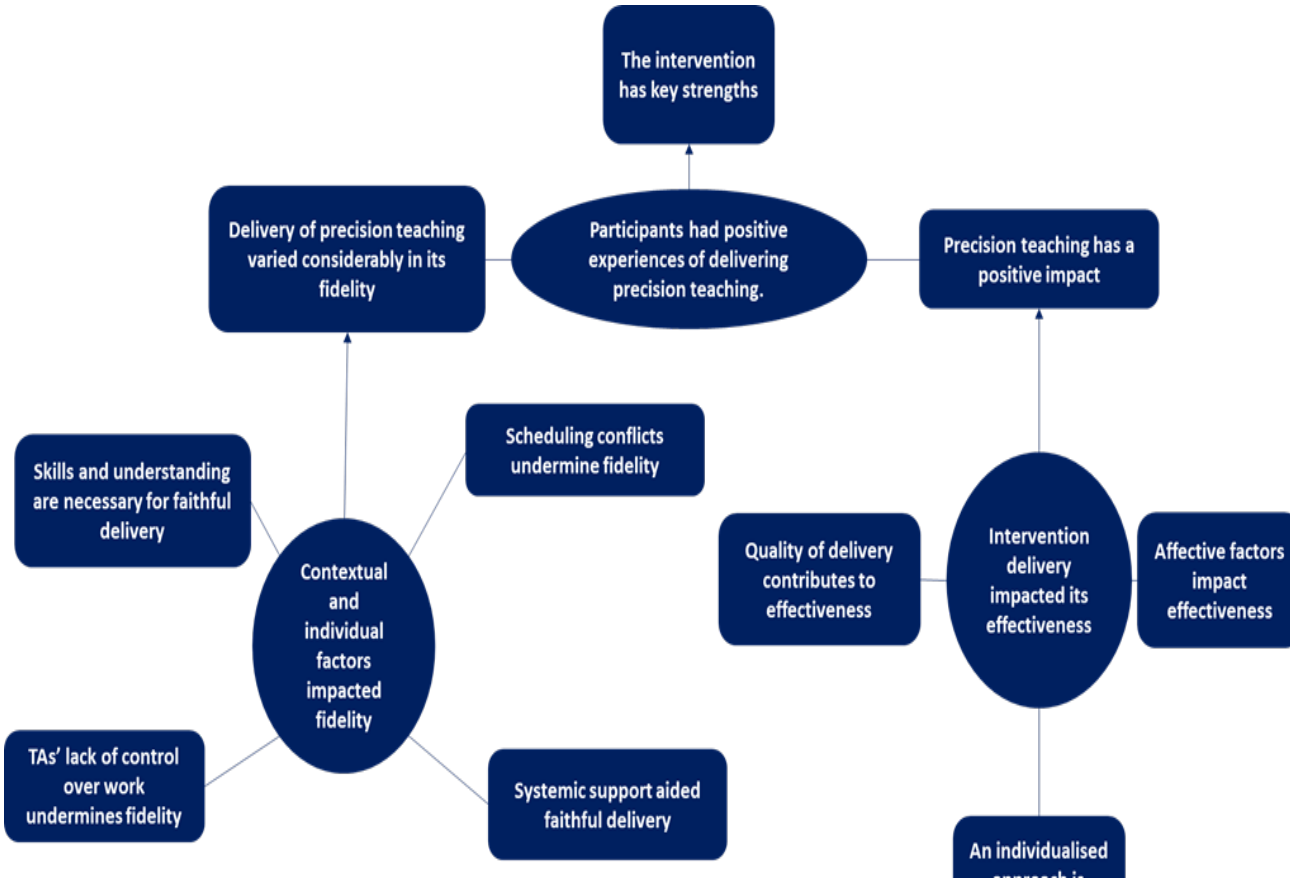


Figure 4 Thematic Map for Teaching Assistants

2.3.2.1 Thematic analysis: Teachers

Theme one: Participants had positive experiences of delivering precision teaching.

The first theme was generated based on teachers' accounts of what it was like to deliver the intervention, focusing on what they did and the impact that resulted. Two sub-themes were generated: Delivery and impact. While the focus of this study was on developing an understanding of barriers to intervention fidelity, teachers provided detailed explanations of their experiences delivering the intervention. This theme therefore provides an important context regarding participants' own views of their delivery of the intervention.

Precision teaching has a positive impact.

The first sub-theme reflects the view of all teachers interviewed that the precision teaching intervention had had a positive impact and allowed learners to make progress in the targeted areas. Both Jane and Poppy highlighted progress that their students had made as the first thing they spoke about regarding the intervention.

Interviewer – Okay. So, to start off just tell me about the intervention. How did it go?

Jane – Erm the child made progress. Probably could have made more progress if I had been doing it more consistently, erm but the erm… this half terms has been manic and other bits of the role take over sometimes, so it wasn't as regular as I'd have wanted it to be.

Poppy – Yeah, so I feel like it worked really well. Erm I only got two children done, um but yeah, I feel like it went really well. Erm their spellings definitely improved so…

During the interview Jane and Pat, mentioned children's ability to see their own success as a specific positive impact of the intervention and mentioned that the success that children experienced in the intervention had led to increases in confidence.

Interviewer – Okay, alright. Erm tell me about a time that the intervention went really well, you felt?

Jane – I don't know if it was week four or week five, that she did have a really good week and made a lot of progress and she could see… she could see the gap on the graph between the crosses and the dots getting bigger and she knew that meant that she was doing really well. So…

Pat – Erm her… she seemed more confident with the words that she was being tested on. So she was like 'oh yeah' as she was spelling them she was verbalising, just saying 'oh yeah, that's right. This is the word that needs the A in it' or 'this is the word that needs the… the B in it' or something. Erm so she seemed more confident with those words that we were learning at the end. So that was good.

While the teachers highlighted a positive impact of the intervention, Harry highlighted that the intervention seemed to be more effective for certain children, while for others it may have been less useful.

Interviewer – Anything else that you felt was particularly good about the intervention, or…?

Harry – Erm it did work for a few of them. I think, because obviously at this point in Year Four they have been taught all of their times tables, it was their recall that was slow. So it did work in, there was about three or four children that I noticed a real difference in, in their speed afterwards, and actually were very successful in their times table check.

Harry – There was one child that it just wasn't working for. It didn't matter how many times we did it, he wasn't motivated to…

Interviewer – Okay.

Harry – You know, to improve his speed or any of those things. So… and because obviously the expectation was also that they were practising them at home and he just wasn't practising them at home. Erm so a little bit of stick worked better there.

Delivery of precision teaching varied considerably in its fidelity.

The second sub-theme outlines how teachers delivered the intervention. This delivery included both the faithful delivery and the deviations that occurred. Katherine, Jane, Poppy, and Pat mentioned visually tracking progress that the students had made, as outlined in the training.

Pat - Erm and then I would then test her with a one-minute timer, like a sand timer, so I would make sure that that bit was as accurate as it could be.

Interviewer – Uh huh.

Pat – Erm and then I would just go through as many of the words as I could on my chart – I don't know what it is – piece of paper.

Interviewer – Probe sheet?

Pat – Probe sheet, yes, that's it. Erm and then she'd just, she'd just write it down and then we'd mark it together, looking at the words. Erm and then we'd plot it together and then by then the other children would be back.

Jane - At the end of that she knew she came and sat with me and we went through the probe sheet, erm and then plotted her scores together, erm and then I took her back to class.

Adaptions to delivery were sometimes made intentionally, but at other times teachers seemed not to realise that they had diverged from the intervention program. All five teachers reported that they did not deliver the intervention every day. Poppy, Jane and Pat reported aiming to deliver the intervention three times a week depending on the timetable. Harry was able to deliver on four days a week. Kathryn was only able to deliver the intervention once or twice a week. None of the teachers identified this as an adaption.

Poppy - I did it, well, I tried to do it three times a week for the four weeks.

Interviewer – Okay.

Poppy – Erm so yeah, but obviously if… because I did it in assembly time, if anything… if assembly got cancelled or anything else came up then those sessions got cancelled.

Interviewer – Yeah, okay. Erm so tell me about any adaptions that you made to the intervention?

Poppy – I'm just trying to think because I don't think I did. I think I stuck to it, exactly what you told us, because I was looking at the PowerPoint that you gave as well and I tried to stick to exactly what you said. Erm so off the top of my head I can't think of any… any changes that I made to it.

Harry and Poppy both changed the teaching component of the intervention by giving the students independent learning tasks to complete rather than engaging in an adult mediated teaching activity.

Interviewer – Okay. Erm so were they doing their learning in a group or were they doing their learning individually?

Harry – Erm individually. It was the same activity every day. It was kind of like, er well actually no, it wasn't. It started off as the same activity every day and then it changed. So we were doing things like multiplication wheels, they were doing erm multiplication booklets which was just like forwards, backwards, division and all that sort of thing. Erm and then they would have a partner next to them that would check that they'd got it right who were secure in their times tables, erm and then they would come and test with me.

Harry shared that he chose not to use the celeration chart at all due to difficulties managing the paperwork. While Kathryn reported that while she and her TA made use of the celeration chart they did not complete it during the intervention but afterwards without involvement from the child.

Interviewer – Yeah. And did you, the charting, you did that with your TA?

Kathryn – Yeah.

Interviewer – So was that afterwards?

Kathryn – She was, she's brilliant.

Interviewer – Oh right.

Kathryn – She had more time than I did, always. So we'd sometimes do it together, sometimes I'd just fill it in. Sometimes I did it wrong, sometimes I did it right. It was a bit of an experiment really. I think when you've not done something before it's just a bit different isn't it?

Harry - Erm and the, I found the paperwork unmanageable with the graphs. So I couldn't do that. That was something that I had to stop because I just…

Interviewer – Okay.

Harry – With nine of them, in the time, because I only had half an hour that I could really do it for, I couldn't… couldn't keep up with that so I didn't do that part of it.

Theme two: Intervention delivery impacted its effectiveness

The second theme was generated to reflect teachers' reports on the factors which led to positive outcomes in the intervention as well as barriers to progress. Three sub-themes were identified: learner engagement, quality of delivery, and individualised approach.

Fun activities and seeing success promote motivation and engagement

The sub-theme of learner enjoyment and success was generated as a key contributing factor to the success of the intervention. Jane, Kathryn and Pat all mentioned the importance of a fun and active teaching activity to support students to engage in the intervention.

Kathryn – Okay, uh huh. Okay, so for him it was a little longer, maybe about fifteen minutes rather than kind of ten, just because he needed time to get into what we were doing. Otherwise it just would have taken him a while to… but we would, say on a good day we would do erm about five, ten minutes of the activities, whoever we were… the really fun one we did was he had to search for the words. I'd hidden them in the classroom during assembly and he had to like run round and find them and shout them out at me and say other things. Because he was doing like see to say ones, he wasn't doing spellings or anything.

Interviewer – Yeah.

Kathryn – But sometimes we would practice the words in like sand or whatever just because he's quite a… just needs something to do. So yeah, he would either run round and look for them and shout them out at me and cheer if, you know, erm just to practise.

Kathryn and Harry both noted that children were motivated to engage in the intervention. With Kathryn highlighting that children were motivated by seeing their success while Harry felt that learners were motivated to beat their targets.

Interviewer – Okay. Erm… okay. So tell me a bit about a time when you felt it went really well?

Harry – Erm I quite liked how the children were quite engaged with beating their score.

He also highlighted the importance of rewards for promoting learner engagement.

Harry – So what I was doing was, because there was nine of them, to try and add a bit more of a competitive edge to it I was putting their score for the day up on the board, erm and the top three scores got a click, so they got a reward. Erm and they liked that 'are we doing it today?' because they wanted that opportunity to get a reward. So they were engaged through the reward aspect of it.

Finally Harry highlighted that the motivation of the student plays an important role in how successful the intervention was with an unmotivated learner making little progress.

Harry – There was one child that it just wasn't working for. It didn't matter how many times we did it, he wasn't motivated to…

Interviewer – Okay.

Harry – You know, to improve his speed or any of those things.

An individualised approach is essential.

All five of the teachers highlighted the importance of tailoring of precision teaching intervention to the individual students to support the effectiveness of the intervention. Harry, Poppy and Pat all highlighted the importance of setting bespoke targets while Poppy, Harry and Jane highlighted choosing teaching items based on the child's ability.

Poppy – Erm I think with the other child I was doing it with, she is working at a Year One level so I chose really simple words like 'do' and 'by', words like that. Erm but I think I put the, er I can't remember what it's called, the pass rate, I think I put that too high.

Interviewer – Okay.

Poppy – Erm so I had to lower that. But obviously you don't know until you try it. Erm but yeah, that was… it was quite hard trying to find that, trying to work out where that should be.

Jane worked to target the intervention by testing the child's knowledge using an initial assessment to identify the focus area and Harry reported relying on his understanding of the child's progress across the course of the year to choose a target area for the intervention.

Jane –Erm so we'd done the initial assessment of key words that she needed to work on, erm and she was quite excited because it was new, erm… and she could see through the graphs and that she was making progress.

Harry – I didn't give them, I didn't do a base test. Because of the point in the year it is I know those kids and I know what they would be capable of so I… I used my kind of knowledge of the children rather than doing a baseline test of them. Erm and that was purely just so we could get going and the time pressure, which was let's get going and see.

Pat highlighted the positive impact of adapting teaching to meet the individual needs of the learner based upon the progress that the student made.

Pat –. Erm I tested her and her score went up quite dramatically, which was quite good. Erm and that was because I decided to change the way I taught it to her, taught the words to her. Erm so I said to her, she kept getting the same words wrong and I said 'No, you need to look at it carefully' and we looked at the words and we spelt it together and we used different colours and things like that, which seemed to help her. So yeah.

Finally, Harry highlighted the need to ensure that the demands of the probe task were well matched with the abilities of the children.

Harry – Erm I think that's it. I did it all so that I said it. I read it out to them and they said the answer. I didn't get them to write it down or anything which obviously didn't fit with the times table method that they would then be tested on. However, in terms of getting the speed up, I didn't want… I have got a few children that are hindered by physical disability.

Interviewer – Yes, mental skills.

Harry – Yes, so I thought it would be easier to do it that way rather than how they would actually be tested. So… it wasn't perfect.

Quality of delivery contributes to effectiveness

The final sub-theme generated was based on the teachers' views that how the intervention was delivered impacted on its effectiveness. Jane and Pat shared that active and fluent engagement from the teacher supported the effectiveness of the intervention.

Jane – Erm I think mainly because the child I'm working with does struggle with concentration attention, that if you're, as the adult working with her, not on top of your game then she'd kind of pick up on that. Erm so if the activities were quite short, snappy, fun activities that she enjoyed she was much more focused, but when I was spending a bit of

time thinking 'okay, what am I doing today? What sheet am I on? Where's the sheet? Where's this?' erm then she'd get distracted and then I think that impacted on her erm when she did the probe at the end of the session.

For Jane and Kathryn a quiet calm space without distractions supported the effective delivery of the intervention.

Kathryn – Because the children are not in the room and it's just me and him. You can focus, he can focus – he's quite erm gets very distracted and is quite slow to pick up on things and to kind of get into an activity. So he needed an amount of time to just get him focused before we even did it. Erm but when there were no other children around, when it was quiet, when he was focused, when I was focused, when I wasn't running off after another child and he wasn't worrying about other things, um yes, so that was kind of when it worked best.

All five teachers identified regular delivery as a key factor in the positive impact of the intervention. Poppy reported that when the intervention was delivered regularly it led to greater improvements for the learner. While for Jane irregular delivery undermined the impact of the intervention.

Interviewer – Yeah, okay. Erm so tell me about a specific time when you felt it went really well?

Poppy – Erm I suppose a week where I was able to get all three done, no interruptions, erm she got them all… or she got, she did the erm, I can't remember what it's called, not the pass rate but you know what I mean…

Interviewer – Yeah.

Poppy – She got that and… and we were able to move on in that same week.

Beyond the importance of learners regularly engaging in the intervention, Harry emphasised the need for the same teacher to regularly deliver the intervention. He reported that inconsistency in delivery when other members of staff delivered the intervention could lead to an inflation of scores.

Harry – Yeah, some of it was. Some of it was the… because of the timetable, if I was taken out to do something else, erm you know, if it's my PPA slot and someone else is covering me, I would explain the process to somebody else but if they weren't as clear on it then they wouldn't necessarily deliver it in the same way that I would. I have always found that their

scores are a lot higher when I came back and I'm thinking 'why is that?' and I don't know whether their minute was more of a generous minute where as I timed it regimentally, or what. But that could sometimes alter that structure I feel.

Theme 3: Contextual and individual factors impacted fidelity.

The third theme generated relates to participants' reporting of factors which supported or hindered their ability to deliver the intervention, according to the outline given during training. Four sub-themes were generated: lack of time, systemic support, understanding and skills, and competing demands.

Staff lacked time to faithfully deliver precision teaching.

All five teachers interviewed indicated that a lack of time undermined their ability to deliver the intervention faithfully. Kathryn found that the lack of time she had to dedicate to interventions meant she struggled to deliver precision teaching sessions.

Kathryn – Okay. So I actually found it very difficult to do.

Interviewer – Okay.

Kathryn – Because I am the class teacher.

Interviewer – Yes.

*Kathryn – So my LSA had also had the same training and she has more time to do interventions. She does interventions separately from this anyway, so for her it was just an extra intervention that she did in her day to day work. Whereas for me finding time to do it as a teacher was really t*ricky.

Harry shared that delivering the intervention with multiple children made it extremely time intensive.

Harry – It was very time onerous but there wasn't anything there that made me go 'oh, I don't like that bit' or anything like that.

Poppy and Pat were able to identify periods during the day when they were often able to deliver the intervention. However, Harry, Jane, and Kathryn shared that there was often no point during the day when the intervention could be delivered.

Kathryn – He probably would have had once a week, twice a week if we were lucky. Yeah. So I think that's a huge thing going forwards, to think about… for us and, yeah, and for

other people who did it I think, yeah, it's hard to do. And little things like if, you know, if I'd done it as soon as they come in in the morning while they are, you know, I could have got them to read or something but you still, I'd still be in the classroom with the other children and stuff always happens.

Systemic support aided faithful delivery.

Teachers also highlighted the importance of systemic support in effectively delivering the intervention. Jane, Harry and Kathryn all highlighted the importance of other adults around the school being aware of the intervention and its requirements to support its faithful delivery.

Harry – Being interrupted. If I had somebody coming in, erm that would delay it because obviously I'd have to stop the timer and that would, you know, put the child off their flow, to then deal with a behaviour issue, somebody coming to ask me a question and those sorts of things.

Jane and Poppy reported that as class teachers they had limited power in addressing systemic and organisational factors.

Kathryn - I think that is a big thing I would change. I can't… I find it, I would love to tell you that I would love to change the time and the availability of myself to be able to do it but I just don't, I cannot see a way out of that. I can't see a solution. I'd like, I am always one of those people that say, you know, if there's a problem you've got to find a solution to it. I can find a solution to me not sorting out the teaching activities but I don't know what the solution is to me being the only one in my classroom all the time. I mean I can think of a solution but it's not up to me to make that decision.

Jane and Harry felt that it was important for senior leaders to be aware of the intervention. Harry and Poppy highlighted the need to prioritise the intervention and Kathryn and Harry suggested including it in curriculum planning.

Kathryn – Erm… I don't know. Possibly if there had been time to make the whole of the leadership team aware that it was happening, particularly because it was kind of a project kind of intervention. Erm then I may have been able to protect my time a little bit more. Erm other than that I don't think so, no.

Harry – Erm… I think maybe if we'd had a conversation about this is our priority so we need to cut back on curriculum and that's okay to do. But I mean it's at my discretion and I could have, you know, cut back on that. But you've still got objectives to hit, haven't you, and I think if we'd had it planned in and we knew that's what we were going to do in September,

we would have planned less in for that term to accommodate that and we would have put those objectives elsewhere.

Skills and understanding are necessary for faithful delivery.

All five participating teachers mentioned their understanding of the intervention and its components and their ability to use them effectively impacted whether they could faithfully deliver the intervention. Katherine, Jane, Harry, and Pat all identified components of the intervention that they struggled to understand or use effectively, including finding the celeration chart difficult to use. The difficulties that they encountered with these often led to them discontinuing the aspects they found challenging.

Kathryn –we'd move him onto some new words but we haven't done it. But we haven't done it. So, I think it's all very well saying right, we're going to do the little teach bit which is like lovely, if we're organised, then the test bit – is that the right way? Yeah. The tracking was easy if we had time to quickly fill in the things and once we got the hang of it, it was okay. And the review bit is easy to do but then I think the next hard, the hard bit now is the… what are you going to do with that review bit. Does that make sense?

Poppy, Jane, Kathryn, and Pat all commented that it was useful to be able to refer back to training notes when they were unsure of what to do. Pat particularly highlighted the importance of having opportunities to practise and develop skills.

Jane – No. There was bits I had to go back and read the… because obviously you do the training and you think 'yes, I know exactly what I'm doing' and then you sit down to do it and think 'oh, do I? What was that bit? What do I need to do there?' So going back to the notes erm and the handout that we were given. So I did that a couple of times, especially initially. Erm but I think everything else within the intervention was covered in the training.

Pat –Everything was quite clear erm in the PowerPoint and we obviously got given the notes that we needed to do it, and we got given the website or the places to go and find what we needed. Erm and we did an example in the session which was really helpful to do, because I think if I didn't have… if I didn't have that example of how to plot it and I just got given it, I think I would just… I would have struggled to do it because it was such a different graph. Erm I can't think of anything else, no. No.

Competing demands undermined fidelity.

Teachers mentioned that in their role they experienced a range of competing demands which would undermine their ability to faithfully deliver the intervention. Jane, Kathryn, Harry,

and Poppy all emphasised that as a teacher there are many aspects to their role and they often felt that these demands took time away from delivering the intervention.

> *Jane – Erm the child made progress. Probably could have made more progress if I had been doing it more consistently, erm but the erm… this half terms has been manic and other bits of the role take over sometimes, so it wasn't as regular as I'd have wanted it to be.*

As class teachers, participants were responsible for the progress of students beyond those with whom they delivered the intervention. Kathryn, Harry, and Pat noted that it was challenging to faithfully deliver the intervention while meeting the needs of the rest of the class.

> *Harry – But in terms of just when you've got thirty children, I couldn't dedicate that much time to nine when the others were getting restless and, you know, understandably had other things to do.*

Moreover, all of the teachers noted that it was difficult to fit in the intervention consistently, given the demands of the school schedule and that they often missed sessions due to regularly timetabled activities and unexpected changes.

> *Jane – Er time. Erm unpredictable things that happen in the school day, erm particularly things like safeguarding which have to take priority. Erm the last couple of weeks, because the child is Year Two, they were practising for their end of year leaver's play, erm so there were a couple of occasions she didn't want to come out and do it because they were practising. Erm or they were, their timetable was completely not what I expected it to be so there was clashes between what I was expecting and what was actually happening in reality on that school day.*

2.3.2.2 Thematic analysis: TAs

Theme 1: Participants had positive experiences of delivering precision teaching

The first theme reflected TAs recollections of delivering the intervention, what they did and the results they achieved. Three sub-themes were identified: impact, strengths of the intervention, and delivery. As in the findings from the teachers, this theme does not relate directly to my research question, however it does provide an important context by outlining participants' reflections on how they delivered the intervention and their views of its impact.

Precision teaching has a positive impact.

All six TAs reported that the precision teaching intervention had been successful in supporting children's learning in the target area. Moreover Becky, Florence, and Michelle all

shared that the intervention seemed to lead to increases in confidence for the children that they were working with, both in the intervention and beyond.

Interviewer – Okay, alright. So is there anything else like generally about the intervention that you just want to mention or flag up there?

Becky – Erm it… for the children that I did it with there were some, there were some good improvements on their number bond knowledge. They grew in confidence and erm when we were doing starters in class you could see that that had erm moved from our group into class and they were more confident about participating in our erm starter activities. So that was nice, for me to be able to see that.

As well as showing improvements within the intervention Michelle also highlighted that following the intervention, learning was generalised back into the classroom with support.

Interviewer – Right, so tell me a bit about doing a precision teaching intervention. How did you find it?

Michelle – Erm I thought it was really, really useful. Erm the child was able to use the words that they had learnt or were learning erm in their everyday work. In their literacy I was able to put them back to erm 'do you remember in the probe sheet that we were using, what was those words? Oh, it was erm the word 'that'. Oh, you are trying to use that in your word now, in your work, so how did we look at that word? It had the s-at, Pat '. And then she used it in her literacy work. Erm when I was using the probe sheets and when we, before we used them we erm did some of the activities where we were writing the words in the sand. Erm we were writing it in glitter. Erm we were using stickers to go over the top of the letters and sticking them over to familiarise herself with them. So yeah, I thought it went really well.

Georgina, Michelle, and Sophie also related that the success learners experienced through the intervention had a positive emotional impact on intervention deliverers.

Interviewer – Erm and then the final question, what was your favourite moment in delivering the intervention?

Georgina – Erm… erm I think there were lots of little moments. Like the feely bag thing when they really enjoyed doing that, because it was something they hadn't done for a long time or they did that for the first time, that was nice because they both really enjoyed it and thought it was really fun. Erm and also seeing that they'd actually made quite a lot of progress at the end and that all the words that I could possibly have fitted in, and when I only did it for six weeks to be absolutely honest, but all the words that I could have possibly

fitted in, at the end of it when I tested them they knew them all and that is a nice, that's a nice feeling. Yeah.

The intervention has key strengths.

All six participants identified aspects of the intervention that they felt made it particularly useful or effective. For Florence, Georgina, Michelle, and Sophie the intervention allowed learners to see when they had made progress.

Sophie – Yes. Yeah, we did it together. Yeah, so I showed them… erm we, I made them count up all the words that they had erm written and then I'd say 'right, let's have a look and see how many we have got right and how many mistakes we've made' and then we'd put a little tick and then there would be a little dot with the ones that they had made mistakes. They were fine with that, no problems. We plotted it together – I think they quite liked going through that bit.

Interviewer – Okay, yes.

Sophie – And that's quite important for them to see how well they are doing, because actually they were like 'wow, I was down there yesterday and now I'm up there' 'I know, it's amazing isn't it'.

Agnes and Michelle both identified the repetition involved in precision teaching seemed to benefit learners. Michelle, along with Florence also felt that the randomised probe was useful to ensure true learning rather than rote repetition.

Agnes – I just think the repetition of it worked really well. So they knew the words and actually, for the first child, it wasn't just a case of using them in that intervention. I was then putting them into a target book for him and he was then using it with his class teacher. So we were expanding the knowledge with the words as well. So he would, you know, they would say 'could you put it into a sentence for me?' and actually then he would come back to me and say 'oh, I know these words already'. And I would say 'I know, but you've only met them one day on your fluency line. We need to do two more days'. But the confidence there built up and I could see that.

Florence highlighted that the intervention was easy to use and Agnes emphasised that intervention sessions were very quick.

Florence – But it is something, I didn't know whether I would be able to do it as a cover teacher but actually it's very easy to pick up.

Interviewer – Yeah.

florence – If it's already set up, to pick up and be able to manage it, which some things like that, you know, interventions you can't.

Interviewer – No.

florence – But I think this one you could. You could keep it going even if the teacher is not there.

Finally Michelle noted that the intervention is extremely versatile and can be used to support learning in a range of areas.

Interviewer – So before we finish, is there anything else that you would like to add that you feel is really important that I… I know about the intervention or how it went?

Michelle – Erm no, because I thought that the ease of it was really good because you can not just do it with key words, I see you can do it with erm numbers and with a range of things. So erm it's nice to be able to take what I've learnt from erm doing this intervention and use it in other areas for other children who also might, erm… like make just even the sheet, of using the idea of erm timing and getting them familiar with erm, say the key words that you need them to learn. It's just that repetitiveness to it that children, erm certain children erm seem to move on from it, to be able to erm… they pick up on more because it's… it's repetitive.

Delivery of precision teaching varied considerably in its fidelity.

All of the six TAs interviewed recounted aspects of delivering a precision teaching intervention. Florence, Georgina, Michelle, and Sophie all recounted how they tracked progress. With Sophie and Michelle referencing visually tracking progress using a celeration chart and Agnes, Georgina and Michelle specifically referencing tracking both the number of correct and incorrect responses.

Interviewer – Okay. Erm and in the erm probing or the tracking, did you have to make any changes?

Michelle – No erm because the ones that she got correct I'd write them in and there was a box there specifically. And then for the ones that she got incorrect. But also she liked to see her chart; she'd like to see her progress. Because when you draw, erm after a week, once you erm line them up with your ruler and then draw the line you, she could see and I'd explained to her that when you see this part here going up, that means you are getting

better and better. When you've reached this line here it means you're at the top and that's like, that's really great. So you can see your progress is going up and up. And she liked to see that.

Florence, Georgina, Agnes and Sophie also highlighted the use of a timed probe in their delivery of the intervention.

Florence – Erm and I will set the timer, are you ready, and then I just read off the sheet. Erm and I just dot when it's correct. Erm and then I put… what did I do? I think I put a question mark by the hesitations and then I spoke to the teacher afterwards. Erm and then literally timed it, wrote down the score.

The celeration chart was a component of the intervention that TAs often adapted. Agnes, Becky, and Michelle all completed the chart without involvement from the child while Florence and Georgina discarded the use of the celeration chart altogether.

Becky – So erm I would do it just one by one, going to get them, sending them back to class after they were done until I had worked through them all. And then obviously erm filling out the graph.

Interviewer – Yeah. And would you do that with them or afterwards?

Becky – Erm I generally would do that afterwards because by that time I'd had them in and out of the class quite a lot, which can be quite disruptive.

All TAs interviewed delivered the intervention irregularly rather than daily as suggested during the training. As with teachers no TAs mentioned this alteration when asked about adaptions that they had made.

Georgina – Erm but I had to ignore that because I couldn't always do it every day. Monday never worked. Tuesday sometimes didn't work. So if they got their targets three days even in a row, even if it was Friday, Wednesday and Thursday, I still counted that as getting their targets.

The teaching aspect of the intervention was also adapted by some participants. Florence gave students an independent learning task rather than an adult led teaching activity and Michelle delivered the teaching session at a separate time from the testing and tracking portions of the intervention.

Interviewer – Okay. And if we think about that structure of the teach, test – you didn't track – but the teach, test erm review, erm was there anything that got in the way of using that structure?

Florence – No, I don't… yeah. Teaching I would say it was more them recalling and practising themselves. It wasn't me teaching anything new. But again, that was because it was times tables. It was more their own time to revise, you know, revisit it.

Theme 2: Intervention delivery impacted its effectiveness.

The second theme identified from TAs reflections on delivering a precision teaching intervention was contributing factors in effective delivery. Participants spoke about a variety of factors that played a role in how effectively they delivered the intervention, some of which supported effective delivery and others which undermined it. Three sub-themes were identified: quality of delivery, affective factors, and individualised approach.

Quality of delivery contributes to effectiveness.

All of the TAs interviewed made comments regarding how they delivered the intervention affected the impact it had. Becky, Georgina, Agnes, Michelle and Sophie shared that having a wide variety of fun activities to complete during the intervention supported learner engagement.

Becky - Erm but it was just trying to find new ways of erm playing fun games to keep them engaged. I sort of would erm change that every so often, so it wouldn't be the… they wouldn't have the same thing every single day. It might be that I'd go back to that same game the next week but they didn't have the same game every… every single session.

Agnes, Michelle, and Georgina all felt that having a wider range of resources or having opportunities to make more resources would have been helpful to improve their delivery of the intervention. Georgina and Michelle noted that the training materials and website were valuable in producing high quality resources.

Michelle – So I thought that was quite good actually. Erm the only other thing I've just remembered that got in the way was maybe the resources.

Interviewer – Uh huh.

Michelle – Because I had erm sand, I had glitter, I had stickers and erm the only other problem was, is erm chalk. I could have used chalk if I had it. Erm there's many other things I could have used if I had it but erm that would have been another part that got in the way of erm… because after a while sand, glitter, stickers, they got a bit tedious.

Interviewer – Yeah. Yeah, okay.

Michelle – And you could see she was feeling a bit like 'can we try something else today?'

According to Agnes, Becky, Georgina, Micelle and Sophie the environment that the intervention was delivered in and the degree to which it distracted the learner influenced the effectiveness of the intervention.

Interviewer – You also mentioned that sometimes finding space was a bit tricky.

Georgina – Erm it can be, yes, because you really need a quiet space don't you.

Interviewer – Mm.

Georgina – And finding a quiet space in a school, it's tricky. You really need just space for the two of you and not a lot of other things going on, and that can be tricky. But mostly we managed it, but it needs a bit of forethought quite often because you might think you can use the library and then a class will come into the library and then you have to get up halfway through and go and move them to the class that's moved into the library because there's a spare classroom there. It's… it's quite tricky to manage.

Agnes, Becky, Georgina, and Michelle highlighted the need for regular delivery to have a positive impact on learning. Florence suggested that when multiple people were delivering the intervention a script might support consistent delivery.

Agnes – No, I don't think so. I think, I mean I think the process itself works. Erm and you… I, as I say, I did see benefits from doing it so it's a shame when there were times it didn't get done because it's frustrating when you know that you can make an impact. And erm when you're unable to do it, erm you can see when you do it the next time that that's had a negative effect on their learning. cover

Affective factors impact effectiveness

All six TAs mentioned the role of affective factors in how effectively they were able to deliver a precision teaching intervention. Sophie, Michelle, Georgina, and Florence emphasised the role of motivation with Sophie and Georgina making reference to students responding positively to having a target to aim for and Florence, Michelle and Sophie all referencing students being motivated by seeing progress. Sophie also observed that when students did not make progress they found it demotivating, which undermined how well the intervention worked.

Sophie - Erm the biggest problems I found for me, I think it's a great intervention because I have done it before with other children and it's worked really well but only on reading, erm the only problems that I found with this one was they didn't very often hit their fluency rate because of their writing speed. Erm so that has always held them back so they haven't really had a large selection of words. They've had minimal ones so erm we were only introducing one or two because they were quite low level children. Erm so that was the problem that I found. When I've done it for reading before, brilliant, and the children have really enjoyed it, they've enjoyed all the activities, the practising… but I found they knew the words very quickly, erm how to spell them, but the writing speed wasn't there so I don't think it really worked for that.

Interviewer – Uh huh.

Sophie – Because it was quite demotivating for the children because we weren't really getting there.

Confidence was another affective factor mentioned by TAs. Agnes and Sophie noted that when students did not feel confident, they struggled to engage in the intervention. Florence recounted how the child had difficulty moving on and completing the probe task when they were unsure they had the right answer.

Sophie – Erm… I think probably when it hasn't gone well, again, would be with the Year Five child when he hasn't been in the right frame of mind to do it, if he hasn't had the best lunchtime. Because I would do it in the afternoon because I have a class in the morning. But apart from that it's been very positive I have to say.

Interviewer – Okay.

Sophie – I do find that with this programme though. We do like it.

Interviewer – Yeah, okay. Erm what would it look like if he hadn't had the… you know, how would that impact on the intervention? Would it just be general motivation? Would it be…?

Sophie – Erm he would get very cross with himself if he made a mistake and then he wouldn't want to do it and we'd say like 'right, just calm down. You know, there's no pressure here'.

Sophie and Michelle highlighted that the timed probe could cause learners to feel pressure and felt that this pressure undermined learners' performance.

Michelle – Erm I would think if you asked the child I think she would probably say erm the time. Because although she liked it, erm some days she loved it and thought it was great and because she was very confident at reading them. And other days she really didn't like the time problem because it… erm when she was looking at it and she was, could see the time, erm it made her stumble a lot more.

Interviewer – Okay.

Michelle – Erm but sometimes she would be very confident. It just depended on her mood I would say.

Interviewer – Yes, okay.

Michelle – Erm sometimes she would be happy to do it and other times she would be like erm very conscious of the timing of it.

Relationships also contributed to the effectiveness of the intervention. Becky Agnes and Sophie highlighted the need to form positive relationships between the TA and learner in order to effectively deliver the intervention. Becky also felt that delivering the intervention in a group allowed learners to support each other and led to more positive outcomes.

Sophie – Erm there wasn't any other people to take it.

Interviewer – Yeah.

Sophie – And they are the sort of children that actually they need to gain your trust to be able to do it.

An individualised approach is essential

The final sub-theme identified was the degree to which the intervention was tailored to meet the individual needs of the child. Georgina, Agnes, and Michelle found it useful to suit the demands of the tasks to the skills of the learner, while Sophie noted that when the task did not fit well with the learner's skills there was a negative impact on students' meeting their targets.

Sophie - Erm the biggest problems I found for me, I think it's a great intervention because I have done it before with other children and it's worked really well but only on reading, erm the only problems that I found with this one was they didn't very often hit their fluency rate because of their writing speed. Erm so that has always held them back so they haven't really had a large selection of words. They've had minimal ones so erm we were only introducing one or two because they were quite low level children. Erm so that was the

problem that I found. When I've done it for reading before, brilliant, and the children have really enjoyed it, they've enjoyed all the activities, the practising… but I found they knew the words very quickly, erm how to spell them, but the writing speed wasn't there so I don't think it really worked for that.

Sophie, Michelle, Georgina, Florence and Agnes all adapted how they delivered the intervention to suit the needs of the learner. Michelle and Florence both mentioned that changing learning tasks based on students' performance in the probe task supported progress while Michelle highlighted the positive impact of actively involving the learner in how the intervention was delivered.

Michelle – And she was like, she would, erm once she understood the way that we were… erm would sit down and the operation of how we were doing it, she would hand me my sheet.

Interviewer – Oh right, so… yeah.

Michelle – So she liked the idea of being like 'this one's yours, this one's mine' and erm 'where's the timer?' So it was very much she was in control of it all and she liked that.

Theme 3: Contextual and individual factors impacted fidelity

The third theme identified from the responses of TAs related to factors which contributed to the faithful delivery of a precision teaching intervention. Within this theme four sub-themes were identified: lack of control, scheduling conflicts, understanding and skills, and systemic support.

Skills and understanding are necessary for faithful delivery

The understanding that TAs had of the intervention and their skill in delivering it impacted how faithfully they delivered the intervention. Florence, Georgina, and Michelle highlighted that there were areas of the intervention that they found challenging and this impacted on how they delivered the intervention. Florence was uncertain about how to score self-corrections and so she did not collaboratively score the probe and share scores with the learners. Georgina struggled to use the celeration chart and therefore eliminated it from her delivery of the intervention.

Georgina – Erm I didn't get on with the graph very well.

Interviewer – No.

Georgina – I just found it too cumbersome. Erm so I did a table. So I literally had erm a correct… I just had a tick and a cross and then erm a table going across it with the days going along like this for about three weeks, and I would just put how many they had got right, how many they had got wrong, how many altogether and then I would record at the bottom, erm or at the top, little notes of the words that they got wrong so that I could remember for tomorrow what we needed to work on.

Florence and Michelle highlighted feeling uncertain about how to deliver the intervention at the beginning and needed practise to be able to deliver it correctly.

Michelle - Erm I did a mock test through first with erm with a different child to see how it would run and what to do first. Erm and it worked really well because my mistakes I made with that child wouldn't have then hindered the child who I was working with and it would have meant that erm it just set me up to… so that I understood what it was that I was doing. Erm I thought the online sheets, erm the… I can't remember what it's called?

Becky, Agnes, and Michelle noted that it was useful to be able to refer back to the training when they were unsure of how to deliver the intervention. Georgina and Sophie felt it might be useful to have more than one training session to support them in implementing the intervention.

Becky – I don't think so. I mean the training was really good. Erm I need, we had all the information that we needed. I referred back to erm the pack that you gave us so from that point of view I had everything I needed to enable me to deliver it. So…

Georgina – Oh maybe, if you could give us more detail on how we could use it in other ways, because I think obviously it could be useful for times tables or elements in Maths. Erm… I know it's used for reading key words, that would be quite clear, but I think perhaps more training in how it could be used in other areas other than Reading and Spelling.

Scheduling conflicts undermine fidelity.

TAs responses indicated that competing demands of the school schedule impacted their delivery of the intervention. All six TAs mentioned that they struggled to fit the intervention in. Becky, Georgina, Agnes, Michelle, and Sophie related how they missed delivering intervention sessions due to competing demands of their own roles and the competing demands of the school schedule.

Agnes – Yeah, I think things crop up don't they and you get asked to cover a class, you know, other interventions and I think… I think towards the end of some terms when you are doing other things and there's music sessions and things like that on your time, it does

change that. But I would say for most of the time it's… it's pretty routine. There's not many sessions that I've missed in the afternoon. I would say I've missed more morning interventions rather than afternoon ones.

Becky, Florence, Michelle, and Sophie specifically made mention of the need to support other students impacting their ability to deliver the intervention regularly.

Michelle – Erm I tried to erm… I could only really sort of do it once a day because erm there were other children that also needed interventions.

Interviewer – Oh yeah, absolutely.

Michelle – Erm so that was the only part that I would say got in the way with erm trying to make it a consistent week. Sometimes if other things got in the way, such as erm the child was needed elsewhere erm and my time is that set time that would be a problem because erm I wasn't able to do it during my designated time. Erm so yeah, I don't… I'd say that was the only thing.

Scheduling conflicts arose throughout daily and annual routine. Florence, Georgina, Agnes, and Michelle all thought it was important to consider when during the day the intervention was delivered. For Agnes and Sophie planning when in the year the intervention was delivered seemed important to support regular delivery.

Sophie – That's just unfortunate. And maybe thinking about when we're going to plan it in the term as to what's coming up for those children erm in the curriculum. Because obviously if they are going out swimming or, I don't know, they've got cooking or whatever, that they can't miss or whatever, so maybe my time and what they're doing in the curriculum and just planning it in in the year.

Georgina – Erm it… yes. Sometimes it was hard to fit in the sessions and it was basically because erm I had to fit them, on the whole, into the afternoons because erm I'm timetabled in the mornings. So in the afternoons erm there's normally time to take my intervention children out and I have two children who are doing precision spellings with me. But on Monday afternoons every week they have, they go for swimming so they just go at one o'clock and we don't see them until the end of the day. And then on Tuesday afternoons there wasn't always a slot because we have, the teachers do erm PPA in the morning so I cover Art all morning with the whole class – obviously I can't take them out then – and then in the afternoon we do Maths and Literacy so it's hard, and I'm meant to be supporting groups in the class. So I couldn't always take them out on a Tuesday afternoon

either. So that meant that Saturday, Sunday, Monday, Tuesday was missing from the programme, which wasn't ideal really.

TAs' lack of control over work undermines fidelity

For five TAs a lack of control over how the intervention was delivered resulted in deviations from faithful delivery. Becky, Florence, and Michelle all made comments indicating a lack of control over how the intervention was delivered and specifically made mention to other members of staff organising the intervention, class teachers and curriculum leads.

Interviewer – Okay, so to start off just tell me a bit about the intervention and how did it go? How did you find it?

Florence – Okay, well I did it from the angle of cover, so I didn't actually set it up.

Interviewer – Okay.

Florence – So I did it really when I was covering with Miss XX.

Interviewer – Uh huh.

Florence – Erm so it was a case of she was doing it with mathematical times tables.

Moreover, Becky, Georgina, Michelle, and Sophie's responses suggested a sense of powerlessness relating to organisational barriers that prevented them from being able to deliver the intervention faithfully. Even when they realised the situation was not ideal they felt there was nothing that they could do to change it.

Michelle – Erm I know that my class teacher was able to do that at one point for me whilst I was out with a behaviour problem. So I was able to sort it out there. In terms, sometimes it's completely out of my hands in terms of like appointments, child absences and sports day and sort of erm different things like that. But as best I could, if I could try and prepare myself erm and organise myself where I spent a bit of time erm maybe before lunchtime if I knew I was covering in an afternoon, I could sit down with that child then. Erm so it didn't matter as such what time of… what time you delivered erm the intervention, as long as you could find the correct time to do it.

Systemic support aided faithful delivery.

TAs also identified the support they received from school systems as a contributing factor to their ability to deliver the intervention. Becky, Georgina, and Sophie felt the school needed to protect their time in order for them to deliver the intervention faithfully.

Sophie - The only problem, erm the other problem that I found was with the role that I've got, erm we've had a child that has been out of school for some time and come back and they've been on a one to one, not back in the classroom. So they had the pleasure of my company. So obviously then I was with them and I couldn't do the intervention. Erm of if there is a problem in class and the SLT aren't free, the staff tend to, they grab me so then my time is pulled. So I have spoken to our SENCO about am I the right person to do interventions because it's not fair on the children and we are not getting the results we want, not because they can't do it but because my time is pulled, so it needs to be a little bit more protected.

More generally, Georgina and Sophie felt that the school needed to prioritise the intervention itself.

Georgina – Erm I think I've probably said most things. Erm I can't think of anything off the top of my head. Erm but it would be nice if, if we were going to do it, if it was made a bit more important to be honest. If it was, because I personally think it is one of the better interventions that we do but it would be nice if it felt a bit more important rather than… I had to suggest that I did it. Nobody said to me 'Do you want to teach these children spellings by precision teaching?' We wanted to teach them spellings and I had to say 'Can I do precision teaching?' And then, yes, I was told yes I could. But if it was something that we automatically did that felt important in the school, erm I think that would be better for everybody really.

Support from other staff impacted how faithfully the intervention could be delivered. Becky, Florence, Michelle, and Sophie noted that support from other members of staff could help them faithfully deliver the intervention, either by freeing their time to deliver it regularly, or by covering when they were unable to deliver it themselves.

Interviewer – Erm so what did you do to overcome barriers to delivering the intervention?

Michelle – Erm I tried as best I could to erm… if I knew that I was needed erm in another classroom, if erm if I was asked for behaviour or if I was asked for something else, that I tried to get an adult that could also erm deliver that, erm deliver the intervention. However there are a limited amount of staff in the afternoons that can do that.

In addition, Michelle referenced the need for other members of staff to be aware of the demands of the intervention, so they did not inadvertently take up allocated time or disrupt the delivery of the-intervention itself.

Michelle – Or erm… or she was needed. A lot of, another erm problem I had was another member of staff took her for an hour erm for another intervention, so I was waiting to be able to fit her in or waiting for her to have her time. So it was trying to make sure that erm I liaised with that grownup to say 'you take her at two' and if I erm, if I sit down with her intervention and do it before that then I know it will definitely fit in.

2.4 Discussion

Based on a critical realist epistemological stance the current study aimed to gain a better understanding of the causal factors in lack of fidelity in precision teaching interventions. Sixteen participants (Teachers N=8) who had received training in precision teaching and thereafter delivered the intervention in their schools completed a questionnaire designed to measure how faithfully they delivered the intervention. Six teaching assistants and five teachers were then interviewed and the data collected was analysed using thematic analysis (Braun & Clark 2006).

Findings from the quantitative data collected through the fidelity questionnaire suggest that fidelity was generally low for both teachers' and teaching assistants' delivery of a precision teaching intervention. Fidelity of intervention delivery was particularly low for the amount of time allocated to teaching tasks and the setting of minimum accuracy markers. Additionally, very few teachers or teaching assistants reported making data-driven adjustments to the teaching approach when the learner did not make progress, which is a core feature of precision teaching interventions (Lindsley, 1992; Potts, Eshleman & Cooper, 1993).

Through thematic analysis of interview data, three identical overarching themes were identified for teachers and teaching assistants. Within these themes several sub-themes were identified; some of which were consistent across groups while others differed for teachers and teaching assistants.

The first theme 'Participants had positive experiences of delivering precision teaching' was largely consistent for teachers and teaching assistants, both of whom discussed their delivery of the intervention (Delivery of precision teaching varies considerably in its fidelity) and the impact it had (Precision teaching has a positive impact). For teaching assistants, this theme also included reflections on the strengths of the intervention (The intervention has key strengths). The second theme 'Intervention delivery impacted its effectiveness' was also largely identical across the two groups with both noting an individualised approach (An individualised approach is essential) and the quality of delivery (Quality of delivery contributes to effectiveness) contributing to the efficacy of the intervention. While teaching assistants also reflected on a range of emotional factors (Affective factors impact effectiveness) that contributed to impact, teachers focused on the role

of learner engagement (Fun activities and seeing success promote motivation and engagement) in the impact of the intervention. The theme in which there was the largest variation between teachers and teaching assistants was 'Contextual and individual factors impacted fidelity'. Both groups identified understanding and skills and the systemic support they received as contributing to faithful delivery (Skills and understanding are necessary for faithful delivery & Systemic support aids faithful delivery). For teachers, the other contributing factors were their lack of time (Staff lack time to faithfully deliver precision teaching) and the presence of competing demands (Competing demands undermine fidelity). In contrast, teaching assistants highlighted the role of scheduling conflicts (Scheduling conflicts undermine fidelity) and their lack of control (TAs' lack of control over work undermines fidelity) as impacting their faithful delivery of the intervention.

In the theme 'Delivery of precision teaching varies considerably in its fidelity' it is apparent that certain aspects of PT were delivered faithfully and some were not, either due to decisions made by the participant or to systemic factors. This reflects participants' responses to the fidelity questionnaire which also indicated inconsistency in faithful delivery. It also reflects previous findings that training does not consistently lead to a comprehensive understanding of the intervention or its faithful delivery (Raybould & Solity, 1988). Several participants mentioned discarding the use of the celeration chart in line with Daly and Cooper's (1993) and Starlin's (1986) studies which both found that the celeration chart was a component of the intervention often omitted by teachers. Other examples of intervention infidelity by participants include not delivering the intervention daily with individual children and introducing additional elements, for example making progress competitive, beyond what is outlined in the intervention. While some participants noted that precision teaching was not effective for all children, they did not seem to make a link between lack of fidelity and impact. Indeed, participants often showed a lack of awareness that they had made adaptions to the intervention which may highlight a lack of understanding of the requirements and components involved.

Overall, however, participants' reflections on the impact of the intervention were generally found to be positive both regarding learning and other affective factors such as confidence. This theme seems to accord with previous findings on the impact of precision teaching for example Roberts and Norwich's (2010) finding of precision teaching's positive impact on reading fluency as well as academic self-concept.

Three sub-themes were identified from participants' responses relating to the impact of the intervention, two of which were found for both groups. The first, relating to the positive impact of an individualised approach reflects the theoretical underpinnings of both learning theory in general and of precision teaching in particular. According to Vygotsky (1987), for a learner to

make progress they must be operating within their Zone of Proximal Development (ZPD), which will differ for individual children. By ensuring an individualised approach when delivering the precision teaching intervention, participants could ensure the learner was operating within their ZPD and therefore maximise progress. Lindsley (1992) highlights the need to target the intervention to the needs of the specific learner based on data collected as a core aspect of the intervention. Therefore, it is unsurprising that participants found an individualised approach crucial to maximising the impact of the intervention. Precision teaching may offer a valuable opportunity to deliver an individualised learning experience to vulnerable learners.

Roberts and Norwich (2010) found a greater impact of precision teaching when implementers were provided with a framework based on good practice to support their delivery of the intervention. This finding seems to correspond with the sub-theme generated (from the responses of both teaching assistants and teachers) that quality of delivery was related to the impact that the intervention had, in those areas where inconsistencies to the model of delivery provided in training were identified by participants as detrimental.

Teaching assistants identified a range of affective factors contributing to the impact of the intervention, while teachers focused on the role of learner engagement. The impact of these emotional and motivational factors on the effectiveness of the intervention seems to correspond well with the research in this area. Tyng, Amin, Saad, and Malik (2017) highlight that, rather than operating separately, emotional and cognitive neural systems are highly interconnected and that emotions can both positively and negatively impact on attention to and retention of learning. Teaching assistants identified that certain emotional factors, such as increased confidence, seemed to support the impact of the intervention, while others, like becoming emotionally heightened by the timed probe, seemed to undermine it. Teachers' comments regarding the role of engagement in progress are supported by a range of studies supporting teachers' views on the link between learner engagement and academic achievement (e.g. Klem & Connell, 2004).

As noted in the introduction to this paper there is a lack of existing literature regarding the factors affecting fidelity and precision teaching interventions. There has, however, been an extensive empirical focus on training transfer or "the extent to which the learning that results from a training experience transfers to the job" Baldwin, Ford and Blume (2009). This literature examines whether training is implemented and leads to organisational change rather than the fidelity of implementation or delivery, however it provides a useful starting point to explore factors which may contribute to intervention fidelity. According to Baldwin et al there are a range of personal and environmental factors that can impact the degree to which learning achieved during training is generalised back to work performance. The findings of the present study would

seem to integrate well into this evidence base as participants identified both internal factors such as their understanding and skills as well as external factors like the systemic support they received from the school as impacting their delivery of the intervention.

Burke and Hutchins (2007) conducted a review of the literature on training transfer and outlined the research on a variety of factors which have been suggested to influence training transfer. Two internal factors, relevant to my findings, which the evidence suggested consistently impacted on this were the cognitive ability and self-efficacy of those receiving the training. This finding would seem to correspond well to participants' reports regarding the impact of their understanding and skills on their faithful delivery of the intervention. Regarding self-efficacy, Burke and Hutchins highlight that this is related to both the generalisation and maintenance of learning achieved in training, suggesting that it was not just participants understanding of the intervention that impacted on its implementation, but also possibly their beliefs about their own abilities.

Another internal factor that has been suggested as playing a role in training transfer according to Burke and Hutchinson (2007) is the locus of control. This seems particularly relevant to the sub-theme identified in TAs' responses related to lack of control undermining their faithful delivery of the intervention. Both Tziner, Haccoun, and Kadish (1991) and Baumgartel, Reynolds, and Pathan (1984), found some evidence (though not conclusive evidence) that an internal locus of control is related to greater training transfer. While it seems likely that TAs' actual lack of control impacted how they delivered the intervention (see environmental factors discussed below), it may also be that their perceptions of lack of control played a part in influencing their faithful transfer of learning from the training to the intervention.

Beyond internal factors, a range of environmental factors have been identified as supporting and undermining the transfer of training back into the workplace. One such factor that was consistently demonstrated to be related to training transfer (Burke & Hutchinson, 2007) was 'transfer climate,' or the degree to which the context supports or undermines the use of learning acquired in training. In the present study, sub-themes relating to factors contributing to faithful delivery referenced, lack of time and competing demands for teachers, and scheduling conflicts and lack of control for teaching assistants. Both groups also identified systemic support as supporting faithful delivery. All of these sub-themes relate to the context in which participants were attempting to faithfully implement their training, suggesting that the transfer climate of the school had a significant impact on the degree to which they were able to achieve this.

Another environmental factor Burke and Hutchinson (2007) consistently found to impact on training transfer was peer and supervisor support. This seems to be reflected in the sub-theme

identified in both teachers' and teaching assistants' responses that systemic support impacted the fidelity of delivery. Both teachers and TAs highlighted the need for support from other members of staff with teachers specifically noting the need for support from leadership.

Finally, Burke and Hutchinson's 2007 review suggests that the opportunity to perform what they have learned impacts trainees' ability to transfer about learning. Both teachers and TAs highlighted sub-themes related to limited opportunities to deliver the intervention: for teachers this took the form of lack of time and competing demands and for TAs it took the form of scheduling conflicts. It seems likely that these limited opportunities to deliver the intervention may have undermined transfer training for participants and therefore their ability to implement the intervention faithfully.

Limitations to the present study

There are several limitations to this study. The first is the dual role that the researcher played of both delivering training and conducting the interviews regarding participants' experiences of delivering the intervention. On the whole, participants were very positive about the intervention: it is possible that the fact that they were speaking to the person who had delivered the training might have led them to be more positive than they might otherwise have been. Burke and Hutchinson (2007) highlight specific aspects of training which can impact the transfer of learning, and it was notable that none of these were reflected in participants' responses. If the interviewer had not been the person who delivered training, then participants might have been more critical of the training and how it impacted on the fidelity of their intervention delivery.

Secondly, there was a high dropout of participants between the training and interview stages of this study. This might have been due to the timing of questionnaire completion, which, for two of the schools, was just before the summer break and, for the other two, just before the Christmas break. Alternatively, it might be the case that few of the staff who received the training went on to deliver the intervention and therefore felt unable to complete the questionnaires. It might have been helpful to have added a question to the beginning of the questionnaire asking participants if they had completed the intervention and asking them to complete only that question if they had not.

Thirdly the core components of precision teaching mentioned above were originally outlined by Lindsley (1991 & 1992) as crucial to the intervention. It should be noted that Lindsley originally designed precision teaching for implementation in specialist settings in the United States. Since its original development therefore precision teaching has spread both beyond a specialist setting and

across cultural contexts. As mentioned above in the decades since its inception alterations to the practical applications of precision teaching have been implemented, for example, marking and charting alongside the learner rather than insistence upon the learner completing this step independently (Roberts & Norwich, 2010). While fidelity to intervention is an important prerequisite for intervention impact, it must of course be considered that changes in where and why the intervention is implemented may lead to alterations being necessary to ensure that the intervention is still fit for purpose. Therefore, alterations to the delivery of precision teaching overtime and across settings may mean that the core components of precision teaching outlined in this study do not reflect current practise in mainstream settings in the United Kingdom. In order to ensure that future research makes use of a standard of fidelity that is applicable to in vivo programme delivery it will be helpful to conduct research to ascertain the current delivery standards in the United Kingdom. This could be achieved either through a survey audit of common training practice across educational psychology services or by conducting a systematic literature review of current precision teaching research in the UK with the aim of identifying common core components implemented. However, while some alterations may be necessary to ensuring effective implementation it will be important to ensure that these departures from the original programme outline are thoroughly researched and evidence based before implementing. Therefore, following on from any such audit of current practise it will be necessary to establish the evidence-base for the positive impact of any updated precision teaching model.

Finally, a bespoke measure of fidelity was developed for this study due to a lack of available tools to measure this. However, participants' responses to the interview indicated deviations from faithful delivery not covered by this measure. If it is to be used in future research it should be adapted to incorporate these additional areas. Furthermore, certain responses from participants indicate that they might not have fully understood the questions (for example responding Not applicable to questions regarding both 'see to say' and 'see/hear to write' probes indicating that neither probe type was used when one must have been), suggesting that the language used should also be revised in places. Further development of this measure could be useful both for future research, by providing a measure of fidelity in this area, and for practice, by providing educational psychologists and school staff a tool with which to audit the delivery of precision teaching interventions in schools. A proposed revision of the tool is provided in Appendix M.

Implications for professional practice

The current study has added to the understanding of fidelity issues in precision teaching interventions. While previous research has looked at the lack of implementation of precision teaching, this investigation has developed an understanding of what may happen during the

implementation of precision teaching interventions. It provides a clearer understanding of why deviations from faithful delivery occur, and this has clear implications for future practice.

Precision teaching is a fast-paced and time boundaried intervention however there are certain time demands of delivering the intervention effectively. This is true both for the need to allocate time to deliver but also for planning and preparation. Educational psychologists must make these demands clear to schools before delivering training to ensure that they are aware of the daily time commitment that the intervention will require. It will be important to clearly communicate these demands to staff and to support their planning around meeting these, one possible method would be to hold an intervention planning meeting prior to training delivery to plan the intervention identify goals and consider time and resource allocation.

Furthermore, the role of systemic support was demonstrated and it will be important for educational psychologists to work with schools, particularly with school leadership, to ensure that those delivering the precision teaching intervention receive the support necessary to deliver the intervention faithfully. This will include making sure that senior leadership is invested in the intervention and are willing to prioritise its faithful delivery. Therefore, it will be important to ensure that staff members in leadership positions and those with authority to make organisational decisions and identify educational priorities are included in pre-training planning. It may also be helpful to ensure that there is a member of the leadership team who will hold responsibility for the intervention and have authority to effectively champion the intervention as it is implemented. This member of staff could both work to address systemic factors that may contribute to fidelity and also play a role in supporting staff to develop their skills and understanding of the intervention.

Finally, it is incumbent upon educational psychologists to ensure that school staff are receiving high-quality training in delivering precision teaching. Trainees must be given sufficient opportunities to develop their understanding and skills and their sense of competence with the intervention. Making sure that suitable time is allocated for the training and giving participants opportunities to practise and develop their skills and understanding. It would also be beneficial to ensure participants receive ongoing support to deliver the intervention possibly through coaching or supervision to ensure that the intervention is delivered faithfully. If, as mentioned above, there is a member of staff with responsibility for the intervention they could work with staff to monitor fidelity, possibly using the questionnaire developed during this study (See Appendix M) and coordinate with the educational psychologist to ensure that staff receive the ongoing training and support they need to develop the understanding and skills necessary to faithfully implement the intervention.

Appendix A Systematic literature review search terms

Literacy								
or				Fidelity				
Read*		Interven*		or				Medic*
or	and	or	and	Faithful*	and	School*	not	or
Writ*		Program*		or				Health
or				Integrity				
Spell*								

… = search term not included in first literature search. included in secondary literature search upon identification through reading of identified papers.

Appendix B Adapted versions of the CASP Cohort checklist

Question	Yes	Can't Tell	No
Are the results of the study valid?			
Was the cohort recruited in an acceptable way?			
Was the exposure accurately measured to minimum bias?			
Was the outcome accurately measured to minimise bias?			
Have the authors identified all important confounding factors?			
Have they taken account of confounding variables in the design and/or analysis?			
Was the follow up of subjects complete enough?			
Was the follow up of subjects long enough?			
Are the results reported with sufficient precision?			
Do you believe the results?			
Can the results be applied to the local population?			
Do the results of this study fit with other available evidence?			
Are there clear implications for future practice?			

Appendix C Adapted versions of the CASP qualitative checklist

Question	Yes	Can't Tell	No
Are the results valid?			
Is a qualitative methodology appropriate?			
Was the research design appropriate to address the aims of the research?			
Was the recruitment strategy appropriate to the aims of the research?			
Was the data collected in a way that addressed the research issue?			
Has the relationship between researcher and participants been adequately considered?			
Have ethical issues been taken into consideration?			
Was the data analysis sufficiently rigorous?			
Is there a clear statement of findings?			
Is the research valuable?			

Appendix D Adapted checklists based on Reichow et al's (2008) group research and single subject research quality indicators.

	Group research		
	Quality indicator	Definition	Score
Primary quality indicators	Participant characteristics	Information on the characteristics of the interventionist was provided	/1
	Independent variable	Information about the treatment was provided with replicable precision (if a manual was used, this was always given a high quality rating)	/1
	Comparison condition	The conditions for the comparison group were defined with replicable precision, including, at a minimum, a description of any other interventions participants received	/1
	Dependent variable	Dependent measures were described with operational and replicable precision Dependent measures showed a clear link to the treatment outcome Dependent measures were collected at appropriate times	/3
	Link between research question and data analysis	Data analyses were strongly linked to the research question(s) The data analysis used correct units of measure (i.e., child level, teacher level, etc.) on all variables	/2
	Use or statistical tests	Proper statistical analyses were conducted for each statistical measure with an adequate power and a sample size >/= 10	/1
Secondary quality indicators	Interobserver agreement	IOA was collected across all conditions, raters, and participants with inter-rater agreement at or above .80. Psychometric properties of standardized tests were reported and were equal or greater than .70 agreement with a K >/= .40	/2
	Random assignment	Participants were assigned to groups using a random assignment procedure	/1
	Blind raters	Raters were blind to the treatment condition of the participants	/1
	Attrition	Attrition was comparable (did not differ between groups by more than 25%) across conditions Attrition was less than 30% at the final outcome measure	/2

	Generalization and/or maintenance	Outcome measures were collected after the conclusion of the intervention to assess generalization and/or maintenance	/1
	Effect size	Effect sizes were reported for at least 75% of the outcome measures and were equal or greater than .40	/1
	Social validity	(a) DVs were socially important (i.e., would society value the changes in outcome of the study (b) intervention was time and cost effective (i.e., did the ends justify the means) (c) comparisons were made between individuals with and without disabilities, (d) the behavioural change was large enough for practical value (clinically significant) (e) the consumers were satisfied with the results (f) people who typically come in contact with the participant manipulated the IVs, (g) the study occurred in natural context	/7

Adapted from Reichow et al 2008.

Strength of research report - Group research	
Strong	Received high quality ratings on all primary quality indicators and showed evidence of four or more secondary quality indicators
Adequate	Received high quality ratings on four or more primary quality indicators with no unacceptable quality ratings on any primary quality indicators, and showed evidence of at least two secondary quality indicators
Weak	Received fewer than four high quality ratings on primary quality indicators or showed evidence of less than two secondary quality indicators

Reichow et al 2008

	Single subject research		
	Quality indicator	Definition	Score
Primary quality indicators	Participant characteristics	Information on the characteristics of the interventionist was provided	/1
	Independent variable	Information about the treatment was provided with replicable precision (if a manual was used, this was always given a high quality rating)	/1
	Dependent variable	Dependent measures were described with operational and replicable precision Dependent measures showed a clear link to the treatment outcome	

		Dependent measures were collected at appropriate times	/3
	Baseline condition	All baselines (a) encompassed at least three measurement points All baselines (b) appeared through visual analysis to be stable All Baselines (c) had no trend or a counter therapeutic trend All baselines (d) were operationally defined with replicable precision	/4
	Visual analysis	Inspection of the graphs revealed (a) all data appeared to be stable (level and/or trend) Inspection of the graphs revealed (b) contained less than 25% overlap of data points between adjacent conditions, unless behavior was at ceiling or floor levels in previous condition Inspection of the graphs revealed(c) showed a large shift in level or trend between adjacent conditions which coincided with the implementation or removal of the IV (note, if there was a delay in change at the manipulation of the IV, the delay was similar across different conditions and/or participants [±50% of delay])	/3
	Experimental control	There were (a) at least three demonstrations of the experimental effect There were (b) at three different points in time There were (c) changes in the DVs covaried with the manipulation of the IV in all instances of replication (note, if there was a delay in change at the manipulation of the IV, the delay was similar across different conditions or participants [±50% of delay]).	/3
Secondary quality indicators	Interobserver agreement	IOA was collected on at least 20% of sessions across all conditions, raters, and participants with inter-rater agreement at or above .80	/1
	Kappa	Kappa was calculated on at least 20% of sessions across all conditions, raters, and participants with a score at or greater than .60 (Good reliability)	/1
	Blind raters	Raters were blind to the treatment condition of the participants	/1
	Generalization and/or maintenance	Outcome measures were collected after the conclusion of the intervention to assess generalization and/or maintenance	/1
	Social validity	(a) DVs were socially important (i.e., would society value the changes in outcome of the study (b) intervention was time and cost effective (i.e., did the ends justify the means) (c) comparisons were made between individuals with and without disabilities,	

	(d) the behavioural change was large enough for practical value (clinically significant) (e) the consumers were satisfied with the results (f) people who typically come in contact with the participant manipulated the IVs, (g) the study occurred in natural context	/7

Adapted from Reichow et al 2008.

Strength of research report - Single subject research	
Strong	Received high quality ratings on all primary quality indicators and showed evidence of three or more secondary quality indicators
Adequate	Received high quality ratings on four or more primary quality indicators with no unacceptable quality ratings on any primary quality indicators, and showed evidence of at least two secondary quality indicators
Weak	Received fewer than four high quality ratings on primary quality indicators or showed evidence of less than two secondary quality indicators

Reichow et al 2008

Appendix E Quality assurance for fidelity factors

Quality assurance evaluation using the CASP cohort study checklist.

Study	*Are the results of the study valid?*	*Was the cohort recruited in an acceptable way?*	*Was the exposure accurately measured to minimum bias?*	*Was the outcome accurately measured to minimise bias*	*Have the authors identified all important confounding factors?*	*Have they taken account of confounding variables in the design and/or analysis?*	*Was the follow up of subjects complete enough?*	*Was the follow up of subjects long enough?*	*Are the results reported with sufficient precision?*	*Do you believe the results?*	*Can the results be applied to the local population?*	*Do the results of this study fit with other available evidence?*	*Are there clear implications for Future practice?*
Zvoch (2009)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*

Quality assurance evaluation using the CASP qualitative study checklist.

Study	*Was there a clear statement of the aims*	*Is a qualitative*	*Was the research design appropriate*	*Was the recruitment strategy appropriate*	*Was the data collected in a way that*	*. Has the relationship between researcher*	*Have ethical issues been*	*Was the data analysis*	*Is there a clear statement*

	of the research?	*methodology appropriate?*	*to address the aims of the research?*	*to the aims of the research?*	*addressed the research issue?*	*and participants been adequately considered?*	*taken into consideration?*	*sufficiently rigorous?*	*of findings?*
Daniel and Lemons (2018)	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*Can't Tell*	*Can't tell*	*Yes*	*Yes*
McIntyre et al (2005)	*Yes*	*Yes*	*Yes*	*No*	*Can't Tell*	*Can't tell*	*Can't tell*	*Can't Tell*	*Yes*
Main, Blackhouse, Jackson, and Hill (2020)	*Yes*	*Yes*	*Yes*	*Can't Tell*	*Can't tell*	*Can't Tell*	*Can't tell*	*Can't Tell*	*No*

Appendix F Quality assurance for fidelity maintenance approaches

Quality assessment scoring for single subject studies

Study	*Information on the characteristics of the interventionist was provided*	*Information about the treatment was provided with replicable precision*	*Dependent measures were described with operational and replicable precision*	*Dependent measures showed a clear link to the treatment outcome*	*Dependent measures were collected at appropriate times*	*All baselines encompassed at least three measurement points*	*All baselines appeared through visual analysis to be stable*	*All baselines had no trend or a counter therapeutic trend*	*All baselines were operationally defined with replicable precision*	*Inspection of the graphs revealed all data appeared to be stable*	*Inspection of the graphs revealed contained less than 25% overlap of data points between adjacent conditions, unless behaviour was at ceiling or*	*Inspection of the graphs revealed showed a large shift in level or trend between adjacent conditions which coincided with the implementation or removal of the IV*	*The leas den of t exp effe*

											floor levels in previous condition		
Browder et al (2007)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Zoder-Martell et al (2013)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Davenport, Alber-Morgan and Konrad (2019)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
O'keeffe, Slocum and Magnusson (2013)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Roberts and Leko (2013)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Study	*There were demonstrations of experimental effect at three different points in time*	*There were changes in the DVs covaried with the manipulation of the IV in all instances of replication*	*IOA was collected on at least 20% of sessions across all conditions, raters, and participants with inter-rater agreement at or above .80*	*Kappa was calculated on at least 20% of sessions across all conditions, raters, and participants with a score at or greater than .60 (Good reliability)*	*Raters were blind to the treatment condition of the participants*	*Outcome measures were collected after the conclusion of the intervention to assess generalization and/or maintenance*	*DVs were socially important*	*Intervention was time and cost effective (i.e., did the ends justify the means)*	*Comparisons were made between individuals with and without disabilities*	*The behavioural change was large enough for practical value*	*The consumers were satisfied with the results*	*People who typically come in contact with the participant manipulated the IVs*

Browder et al (2007)	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*No*
Zoder-Martell et al (2013)	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*No*
Davenport, Alber-Morgan and Konrad (2019)	*Yes*	*Yes*	*Yes*	*No*	*No*	*Yes*	*Yes*	*Yes*	*No*	*Yes*	*No*	*No*
O'keeffe, Slocum and Magnusson (2013)	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*Yes*	*Yes*	*No*	*Yes*	*No*	*No*

Roberts and Leko (2013)	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*No*

Quality assessment scoring for group comparison studies

Study	*Information on the characteristics of the interventionist was provided*	*Information about the treatment was provided with replicable precision*	*The conditions for the comparison group were defined with replicable precision, including, at a minimum, a description of any other interventions*	*Dependent measures were described with operational and replicable precision*	*Dependent measures showed a clear link to the treatment outcome*	*Dependent measures were collected at appropriate times*	*Data analyses were strongly linked to the research question(s)*	*The data analysis used correct units of measure*	*Proper statistical analyses were conducted for each statistical measure with an adequate power and a sample*	*IOA was collected across all conditions, raters, and participants with inter-rater agreement at or above .80*	*Psychometric properties of standardized tests were reported and were equal or greater than .70*	*Participants were assigned to groups using a random assignment procedure*

			participants received						*size >/= 10*			
Vernon-Feagans, Bratsch-Hines, Varghese, Bean and Hedrick (2015)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*
Stein, Berends, Fuchs, McMaster and Saenz (2008)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*Yes*

Study	*Raters were blind to the treatment condition of the participants*	*Attrition was comparable (did not differ between groups by more than 25%) across conditions*	*Attrition was less than 30% at the final outcome measure*	*Outcome measures were collected after the conclusion of the intervention to assess generalization and/or maintenance*	*Effect sizes were reported for at least 75% of the outcome measures and were equal or greater than .40*	*DVs were socially important*	*Intervention was time and cost effective*	*Comparisons were made between individuals with and without disabilities*	*The behavioural change was large enough for practical value*	*The consumers were satisfied with the results*	*People who typically come in contact with the participant manipulated the IVs*	*The study occurred in natural context*
Vernon-Feagans, Bratsch-Hines, Varghese,	*No*	*No*	*Yes*	*No*	*Yes*	*Yes*	*Yes*	*No*	*Yes*	*No*	*No*	*Yes*

Bean and Hedrick (2015)												
Stein, Berends, Fuchs, McMaster and Saenz (2008)	*No*	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*No*	*Yes*	*No*	*No*	*Yes*

Appendix G Example probe sheets and celeration chart provided to during training

See → Say example

Name: …….. Sheet no.: ……

Date begun: …… Date ended: ……..

Objective: to recognise by sight – there, going, with, from, they, went

there	going	with	from	they	5
went	from	there	with	going	10
with	there	going	from	they	15
there	went	with	they	going	20
went	going	from	with	they	25
they	from	there	went	with	30
went	with	going	they	there	35
going	they	from	went	with	40

from	there	they	going	went	45
with	they	from	there	went	50

See → Write example

Name: …….. Sheet no.: ……

Date begun: …… Date ended: ……..

Objective: 4 times table

1x4=	4x4=	3x4=	2x4=	5x4=	5
3x4=	2x4=	5x4=	4x4=	1x4=	10
4x4=	5x4=	3x4=	2x4=	1x4=	15
5x4=	1x4=	2x4=	3x4=	4x4=	20
3x4=	2x4=	5x4=	4x4=	1x4=	25

2x4=	4x4=	3x4=	5x4=	1x4=	30
1x4=	5x4=	4x4=	3x4=	2x4=	35
5x4=	3x4=	2x4=	1x4=	4x4=	40
1x4=	4x4=	5x4=	2x4=	3x4=	45
4x4=	2x4=	3x4=	5x4=	1x4=	50

Say → Write example

Name: …….. Sheet no.: ……

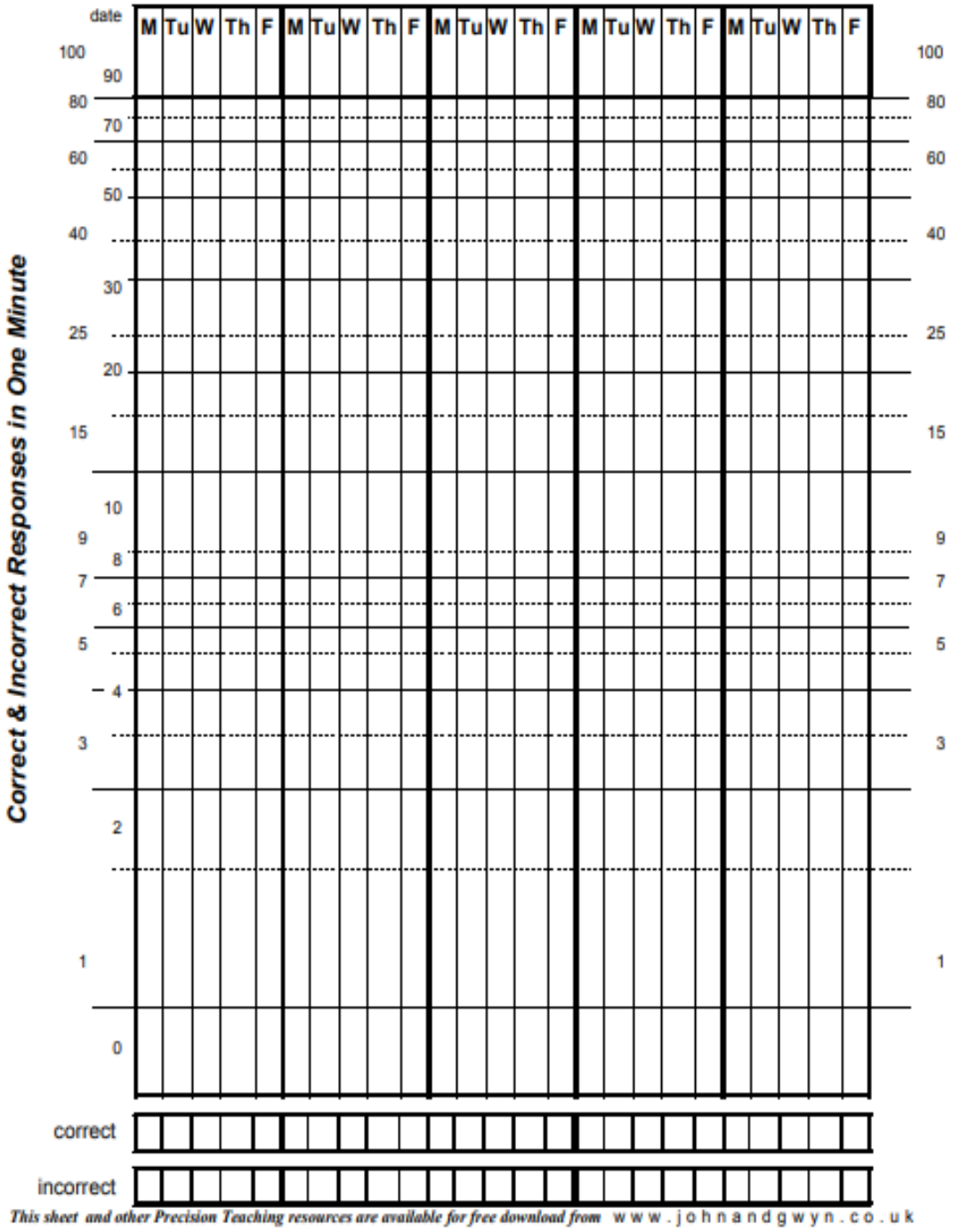
Date begun: …… Date ended: ……..

Objective: to correctly form the letters a, d, g, q

					5
					10
					15

					20
					25
					30
					35
					40
					45
					50

Plot "correct" score with a ● and "incorrect" score with a **x** in the between the grid lines.



Appendix H Training Materials

Appendix I

Precision Teaching

Claudia Stubington
Trainee Educational Psychologist

1

Session Aims

- What is Precision Teaching?
- PT: The underlying theory
- How do you do PT?
- Two rules of thumb
- Setting up your PT programme

2

What is Precision Teaching?

- Precision Teaching (PT) is a method of precisely measuring the effectiveness of teaching.
- We could think of it as precision monitoring of learning progress.
- PT helps to identify which teaching approaches work for individuals.
- It is a way of ensuring forgetting is minimised.

3

What is Precision Teaching?

Precision Teaching:

- Is highly structured and based on the psychology of learning
- Monitors learning in a very specific area
- Involves teachers, children and LSAs working together
- Requires approximately 15 minutes per day 1-1 teaching
- Develops accuracy and speed (fluency)
- Is based upon pupils succeeding

4

When can it be used?

When a child is making little or no progress in an area.

When development of speed is essential for progress, for example:

- phonics
- sight vocabulary
- spelling high frequency words
- number recognition
- number bonds

For teaching skills that are measurable and need to be acquired to make progress

5

Why does PT work?

- It is specific:
  Individual learning needs/targets are identified and taught/addressed
- It is flexible:
  Can be used in a variety of curriculum areas to help work towards IEP targets
- It ensures success:
  Children improve against their own performance and see progress on their charts each session. Promotes growth mindset
- It can make learning more fun:
  staff can use games and creative methods to teach specific skills
- It is quick and easy to run:
  Only requires 15 minutes of 1-1 contact per day and can be run in school and at home

6

Problems with many 'off-the-shelf' programmes...

- Targets are pre-set, rather than individualised according to the child's progress.
- Accordingly, no way of altering targets.
- Lack of systematic monitoring of progress.
- Less clarity to the child on his/her progress.

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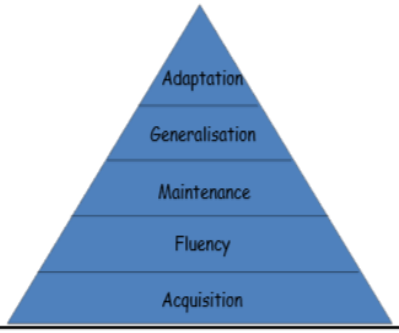
Basic skills learning hierarchy (Haring & Eaton)



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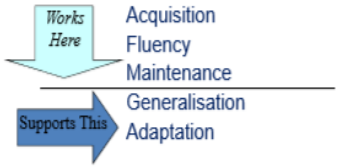
PT: The underlying theory

'The Learning Hierarchy' (Haring & Eaton, 1978)



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PT: Six Basic Steps

1. Set targets of the child's in observable and measurable terms
2. Deliver short sharp teaching sessions
3. Measure progress on a daily basis
4. Chart progress on a daily basis
5. Record teaching approach in relation to child's progress
6. Review data with the child to check if:
   - Progress is satisfactory
   - Changes to teaching approach are needed

(Solity and Bull, 1987)

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Before you start Precision Teaching...

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'Task Analysis'- Where are they now?

You need to:

1. Select a problem area, e.g. letter sounds
2. Find out what the child already knows, probably by doing a short test
3. Choose the next steps for the child, e.g. which are the next letters he/she needs to know (usually between 3 and 5 letters, words or numbers)

13

I	✓	it	.	dad	
you	.	we	✓	cat	.
he	.	they	.	dog	.
she	.	mum	✓	day	.
a	✓	the	.	am	✓
is	.	are	.	was	.

The pupil was tested with the 100 high frequency words to identify the specific difficulties.
The pupil can read 5/18 words.

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Setting targets (Aim rate)

Aim rates are a combination of

1. Fluency- number the child gets right in a minute
2. Accuracy – number the child gets wrong in a minute

You need to set targets for both; how many the child needs to get **correct** *and* how many **errors** they are allowed to make each time

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Types of Precision Teaching Tests

- See-to-say — e.g. reading the letters written down
- See-to-write — e.g. writing the answers to mathematical computations 3 + 6 = ?
- Say-to-write — e.g. spellings/letter sounds dictated by LSA

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Setting Aim Rates

Suggested minimum Fluency Markers:

See to say sight vocab:

Infant Pupils = 40 cpm
Junior Pupils = 50 cpm

Suggested minimum Accuracy Markers: 3 errors or less

See/hear to write

Infant Pupils = 15 cpm
Junior Pupils = 30 cpm

Suggested minimum Accuracy Markers: Up to 10% of fluency rate e.g. 40 cpm = 4 mistakes or less

MAINTENANCE = ACHIEVE THE TARGET FOR 3 CONSECUTIVE DAYS

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What you will need

- teaching materials
- 1 precision teaching grid (test)
- 1 record sheet to show progress
- stopwatch or sand timer

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Precision Teaching: the daily routine

Teach	Test	Track	Review
Short teaching sequence, focused on current target skill.	One minute timed fluency test.	Chart results of test with child.	Review progress with the child.
Fun, enjoyable, fast-paced.	Following test, share mark with child.	Record the number of correct an incorrect responses	Decides hether learning is on track and whether to alter teaching method
6-8 minutes	1 minute.	2-3 minutes.	2-3 minutes

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Step 1: Teach

Each PT session will begin with 6-8 minutes of teaching

Teaching should

- Be short and sharp- allowing each item to be covered more than once.
- Give feedback- provide the child with information about correct or incorrect responses

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Step 2: Test

Each teaching session will be followed by a 1 minute test of learning called a Probe

Test should

- Be consistent- make use of a probe grid
- Be timed- last exactly one minute

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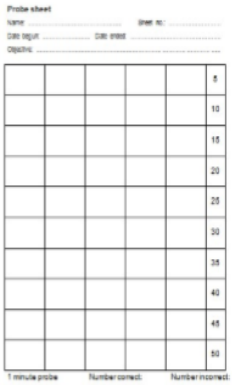

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PT Probe Generator

http://johnandgwyn.co.uk/probe.html

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Activity – probing exercise

- In pairs, choose one person to be the learner and one person to be the teacher
- You have 5 minutes to learn the number-word association
- Probe-1 minute

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Step 3: Tracking

- Following a one minute probe.....
- Date it!
- Record number correct and incorrect in boxes below
- Plot 'o' correct , 'x' incorrect on chart
- Review with pupil (praise the child for making progress, areas to work on etc...)

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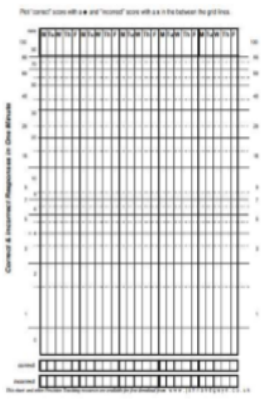
Step 3: Track (For completion with the child)



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Tracking

Using the results of the probe

The chart should contain:

•Aim Rate

•Number of correct responses

•Number of incorrect responses

•Learning curve (correct responses over time, goal to reach the AIM RATE)

•The number of incorrect responses indicates the pupil's accuracy level

Success is achieved when the child reaches the target on three consecutive days

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Activity – tracking exercise

- Look at Natasha's results sheet
- Enter the scores on the chart
- The first two days have already been plotted
- Would the task be continued after 19.01.01?

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Review

Two rules of thumb:

Rule 1: Three Day Rule

If noticeable progress is not made within the first three days then the task is too hard or the teaching method is not appropriate.

Options: **Change task or skill slices:**

- size of the task (number of items)
- Task difficulty (reduce range/interleave)

Change the teaching method

Do not change the aim rate!

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Review

Two rules of thumb:

Rule 2: Eight Day Rule

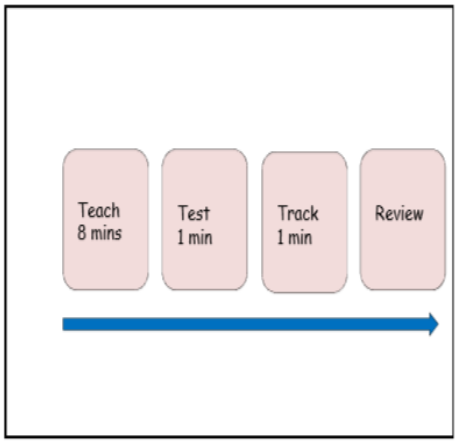
If the child is not at or very near to the aim rate after 8 days

Options:

- **change** the teaching method,
- **aim to increase** pupil motivation

Do not change the aim rate!

30



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Interleaving (Solity et al., 2000)

List 1	List 2	List 3	List 4	List 5
and	it	in	with	have
the	is	and	a	to
a	my	on	he	play
I	go	the	I	it
to	went	we	was	of

Built in review ('mixed probe') increases retention and confidence

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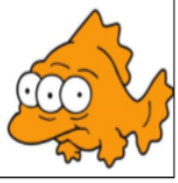
Fatal mutation

The alteration of an intervention – with the best of intentions, and in a manner which the professional considers sufficiently consistent with the original intervention that they can still claim they are implementing it – such that its impact becomes negative rather than positive.



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Resources

"A Minute A Day", Sheila Crompton
(£13.50)
Timesavers Publishing

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Resources

Precision teaching probe generator:

http://www.johnandgwyn.co.uk/probe.html

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Precision Teaching

Resource Pack

With thanks to [redacted]

Contents

Probing exercise – Number-word association

In pairs, choose one person to be the learner and one person to be the teacher.

You have five minute to learn which word goes with which number.

1	2	3	4	5
Sam	Jet	Big	Fog	Mud

Probing exercise – learner

1	2	3	4	5	5
4	3	2	5	1	10
3	5	4	1	2	15
5	4	1	3	2	20
1	3	2	4	5	25
4	5	2	3	1	30
3	1	4	5	2	35
5	3	2	1	4	40
1	2	3	4	5	45
4	3	2	5	1	50

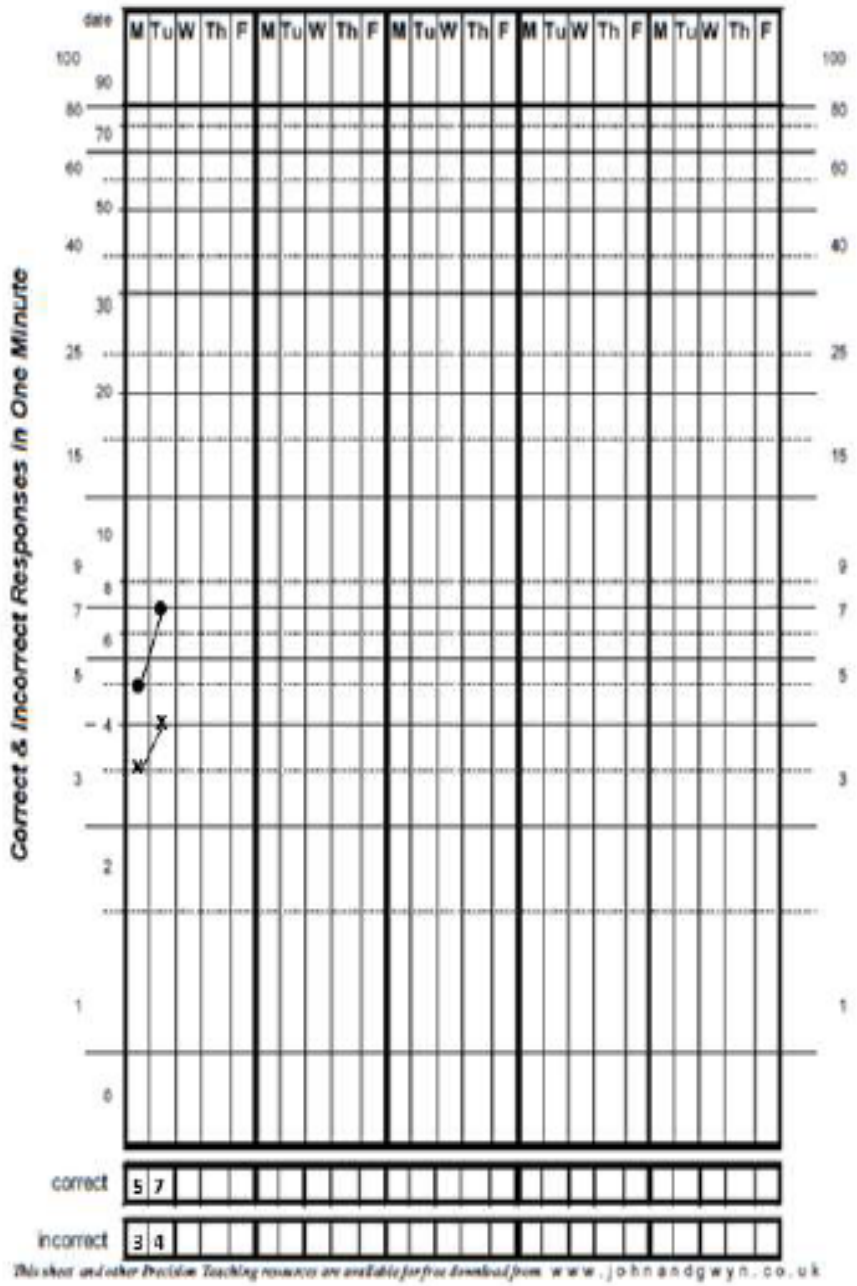
Precision Monitoring Record Chart

Pupil:

Aim rate: correct per min

Incorrect per min

Plot "correct" score with a ● and "incorrect" score with a x in the between the grid lines.



Remember: do not join across weekends or across days when fluency was not tested

6

See → Say example

Name: ..... Sheet no.: .....

Date begun: ..... Date ended: .....

Objective: to recognise by sight – there, going, with, from, they, went

there	going	with	from	they	5
went	from	there	with	going	10
with	there	going	from	they	15
there	went	with	they	going	20
went	going	from	with	they	25
they	from	there	went	with	30
went	with	going	they	there	35
going	they	from	went	with	40
from	there	they	going	went	45
with	they	from	there	went	50

7

See → Write example

Name: ..... Sheet no.: .....

Date begun: ..... Date ended: .....

Objective: 4 times table

1x4=	4x4=	3x4=	2x4=	5x4=	5
3x4=	2x4=	5x4=	4x4=	1x4=	10
4x4=	5x4=	3x4=	2x4=	1x4=	15
5x4=	1x4=	2x4=	3x4=	4x4=	20
3x4=	2x4=	5x4=	4x4=	1x4=	25
2x4=	4x4=	3x4=	5x4=	1x4=	30
1x4=	5x4=	4x4=	3x4=	2x4=	35
5x4=	3x4=	2x4=	1x4=	4x4=	40
1x4=	4x4=	5x4=	2x4=	3x4=	45
4x4=	2x4=	3x4=	5x4=	1x4=	50

Say → Write example

Name: ..... Sheet no.: .....

Date begun: ..... Date ended: .....

Objective: to correctly form the letters a, d, g, q

					5
					10
					15
					20
					25
					30
					35
					40
					45
					50

Probe sheet

Name: ..... Sheet no.: .....

Date begun: ..... Date ended: .....

Objective: .....

					5
					10
					15
					20
					25
					30
					35
					40
					45
					50

1 minute probe Number correct: Number incorrect:

Probe sheet

10

Name: ..... Sheet no.: .....

Date begun: ..... Date ended: .....

Objective: .....

					5
					10
					15
					20
					25
					30
					35
					40
					45
					50
					55
					60
					65
					70
					75
					80

1 minute probe Number correct: Number incorrect:

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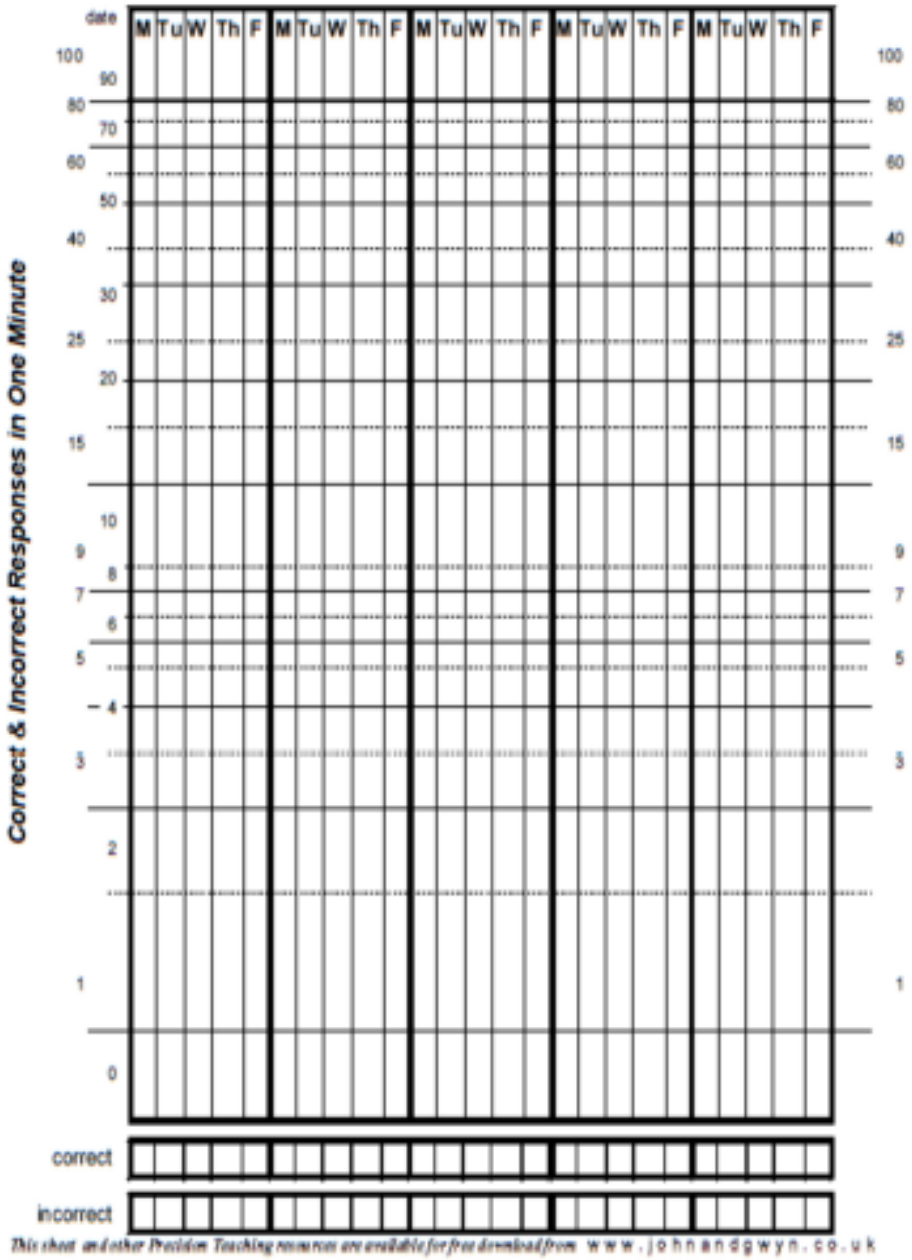
PRECISION MONITORING RECORD CHART

Pupil: Criterion: Corr. P. min. with max errors

Plot "correct" score with a ● and "incorrect" score with a x in the between the grid lines.



This sheet and other Precision Teaching resources are available for free download from www.johnandgwyn.co.uk

12

Precision teaching programme plan

Pupil Name:	Date Set:
School:	Delivered by:

Task			
Target	Accuracy= Fluency = Maintenance=		
Teaching activities			
Programme 1	Programme 2	Programme 3	Mixed Probe
Programme 4	Programme 5	Programme 6	Mixed Probe

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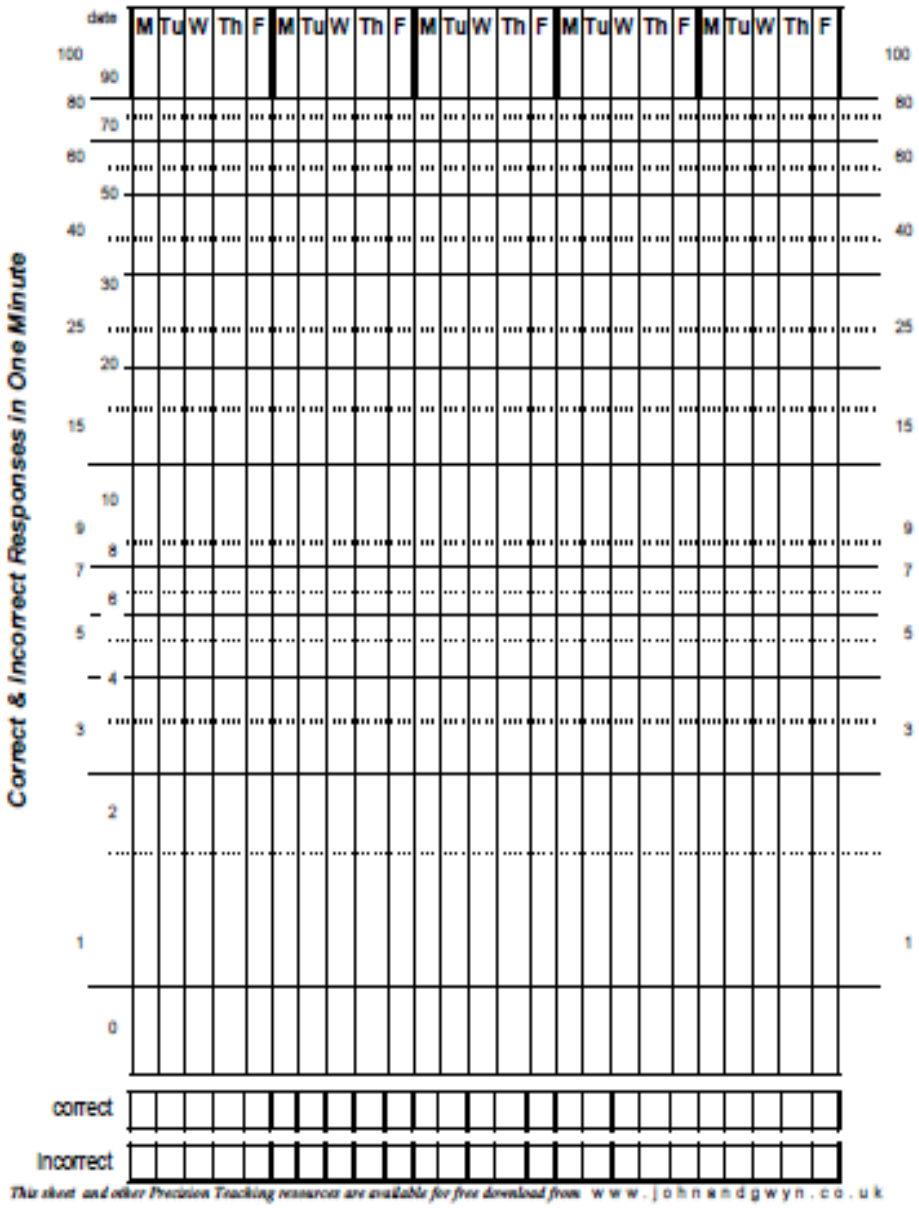
name: ..... group/class: .....

Individual Precision Teaching Probe Record

Sight words for this probe:

Plot "correct" score with a ● and "incorrect" score with a x in the between the grid lines.



Precision Teaching Activities

Letter and number recognition

- **Bingo** – child is given a piece of card with letters/ numbers written on it (from probe sheet). LSA calls out a letter/ number and the child draws over the matching one on their card (could use bingo blotter or felt tip pen)
- **Alphabet/ number grid** – child places hand into a feely bag, which contains plastic letters/ numbers (from probe sheet) and draws one out. Child says letter/ number aloud and places onto an alphabet/ number grid
- **Jumping game** – letters/ numbers (from probe sheet) are written onto individual A4 pieces of paper and placed on the floor. LSA calls out letter/ number and the child jumps onto the matching A4 piece of paper
- **Building blocks** – child and LSA work together to build a tall tower, using building blocks with letters/ numbers written on them (from probe sheet). When placing a building block onto the tower, the letter/ number should be said aloud.
- **Sand drawing** – LSA says letter/number (from probe sheet) aloud and child draws this into the sand

Phonics

- **'A minute a day' by Sheila Crompton** – containing photocopiable games, each of which focuses upon a specific letter or group of letters

High frequency words

- **Simultaneous oral selling technique** (from Precision Teaching training)
- **Visual learning technique** (from Precision Teaching training)
- **Board games** – from online sources
- **Spelling using magnetic letters** – LSA asks child to spell out the word (from probe sheet) using the magnetic letters. If child is very unsure, the word could be written out and the child places the magnetic letters on top, saying the letter names aloud as they do so
- **Internet games:**
    - http://www.ictgames.com/dinosaursEggs/ - covers top 300 high frequency words. However, each level contains a set number of words so these cannot be manipulated to just focus on those you're currently working on
    - http://www.ictgames.com/highFreq/ - covers top 300 high frequency words. Bingo cards can be printed from the website, however it may be worth making own bingo cards so they only contain the words you're working on (from probe sheet). Child says word aloud as they tick it off bingo card

- Look, say, cover, type & check game from http://www.crickweb.co.uk/ks2literacy.html - this allows you to input your own spellings (from probe sheet) and asks the child to follow the look, say, cover, type and check process

Number bonds

- **Pairs** – numbers (0-10) are written onto two coloured pieces of card and cut out. LSA has one set of 0-10 cards and child has the other set. Using the number bonds you're currently focusing on (from probe sheet), LSA places a card down and the child places the correct number bond from their pile
- **Bingo** – child is given a card with numbers written on it (from probe sheet). LSA calls out a number and the child draws over number bond on their card (could use bingo blotter of felt tip pen)
- **Jumping game** – numbers (from probe sheet) are written onto individual pieces of paper and placed on the floor. LSA calls out a number and the child jumps onto the correct number bond

Times tables

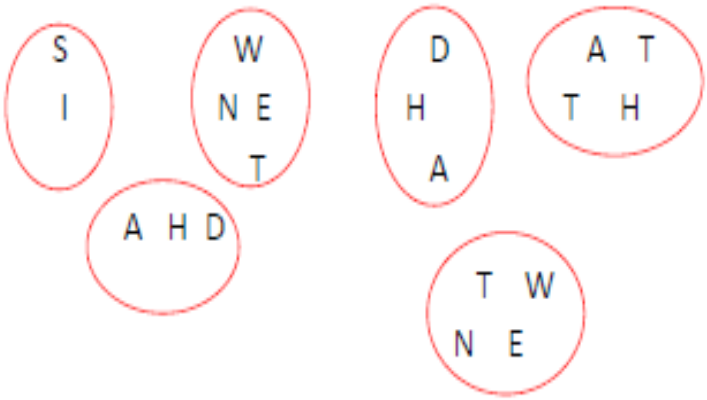
- **Chant times tables** – "1 times 2 is 2, 2 times 2 is 4..." This could be recorded onto a tape and the child aims to beat the answer before it gets played on the tape
- **Snap** – the sum (e.g. 4 x 2 =) should be written on half the cards and the answer (e.g. 8) should be written on the other half. LSA has the sum cards and the child has the answer cards (both face down). LSA places first card face up in the middle. Child turns over their top card and checks if the card has the correct answer on it. First person to say snap takes the cards

Precision Teaching Activities

- Jumbled Letters Activity

  Can you find these words below?

  is that had went



- Postboxes:

Child picks envelope, reads the word and then posts it in the correct postbox

- Finger tracing in rice/carpet tile

- Play-doh

9466607

Ideas from: www.phonicscloud.com

- Shaving foam

- Glitter trays

- CVC Stones

- Blending marbles

- Sorting activity

- Magnetic letters

- Painting on bread

- Fly swatting

9466607

- Scrabble spelling

- Building blocks letter/number

- Balloon game

- Football/hockey

- Spin the bottle

- Chalk writing / jumping

- McPhonics

9466607

- I-Spy bottle

- Phonics fishing

- Alphabet ping pong

- Water fence painting

- Hoop jumping

- Bean bags and buckets

- Hide and seek / word hunt around playground

9466607

Appendix J Fidelity questionnaire (answers that would have earned a score of 1 are highlighted in yellow)

Researcher name: Claudia Stubington
ERGO number: 47800
Version 1

We are aware that in day to day practice in schools there are factors that affect the delivery of interventions that can lead to changes in how the intervention is implemented. We are interested in understanding the barriers to delivering precision teaching programmes and the adaptions that can result.

In this questionnaire you will be asked about your experiences of delivering a precision teaching program. To help us learn about the barriers you experienced and the changes that they may have led to, please answer all questions based on how you delivered the intervention rather than making reference to training materials. Please be honest in your answers – this is not a test of your ability, but a questionnaire about what you have done, and the more true a picture we can generate from questionnaire answers, the better we can understand precision teaching implementation and what needs to happen in order to maximise its impact.

All information from questionnaires will be treated in the strictest confidence.

1) For how many children have you delivered a precision teaching intervention?

2) For how many weeks have you delivered the precision teaching program?

3) How did you decide where to focus your Precision Teaching program?
   a) Consulted with staff to discover the gaps in the child's knowledge
   b) Did a short test to find out what the child knows
   c) Chose key items from the curriculum that term
   d) Consulted with the child to see what they wanted to cover
   e) Other:_____

4) How many items did you teach at a time?
   a) 1-2
   b) 3-5
   c) 6-8
   d) 9-11
   e) Other:_____

5) What kind of targets did you set for the child to meet before they could move on to the next teaching items?
   a) Did not set targets
   b) The maximum number that they could get wrong
   c) The threshold number that they should get right
   d) The maximum incorrect and the threshold correct
   e) The target time for them to complete the probe sheet
   f) Other:_____

6) What aim rates did you use to set targets for see to say probes?
   a) Did not set aim rates
   b) 15 items correct for infant pupils and 30 correct for juniors.
   c) 40 items correct for infant pupils and 50 correct for juniors.
   d) 60 items correct for infant pupils and 70 correct for juniors.
   e) Individual aim rates based on measures of the child's fluency on known items
   f) Other:_____

7) What minimum accuracy markers did you use for see to say probes?
   a) Did not use minimum accuracy makers
   b) 3 errors or less in a minute
   c) 10 errors or less in a minute
   d) Errors up to 10% of the fluency rate
   e) Individual accuracy markers based on measures of the child's errors on known items.
   f) Other:_____

8) What aim rates did you use to set targets for see/hear to write probes?
   a) Not applicable - did not use see/hear to write probes
   b) Did not set aim rates
   c) 15 items correct for infant pupils and 30 correct for juniors
   d) 40 items correct for infant pupils and 50 correct for juniors
   e) 60 items correct for infant pupils and 70 correct for juniors
   f) Individual aim rates based on measures of the child's fluency on known items
   g) Other:_____

9) What minimum accuracy markers did you use for see/hear to write probes?
   a) Not applicable - did not use see/hear to write probes
   b) Did not use minimum accuracy makers
   c) 3 errors or less in a minute
   d) 10 errors or less in a minute
   e) Errors up to 10% of the fluency rate

f) Individual accuracy markers based on measures of the child's errors on known items.
g) Other:_____

10) How long did you spend on the teaching section of the session?
    a) Went straight to the probe
    b) 3-5 minutes
    c) 6-8 minutes
    d) 9-11 minutes
    e) Other:_____

11) What kind of teaching activity did you use?
    a) Went through the probe sheet
    b) A quick activity that gave the child feedback on each response
    c) A quick activity that gave the child feedback at the end
    d) Worked through each item and discussed it at length
    e) Other:_____

12) How did you test the child's fluency?
    a) Did not test the child's fluency
    b) Repeating the teaching activity and scoring it
    c) Using a probe grid
    d) A quiz
    e) Saying the items for the child to record in their spelling book
    f) Other:_____

13) How long did your test last?
    a) Did not use a test
    b) As long as it took for the child to read all the probe items.
    c) 30 seconds
    d) 1 minute
    e) It varied according to the session
    f) Other:_____

14) How did you score the child's performance?
    a) Did not score the child's performance
    b) Counted the number of correct responses
    c) Counted the number of incorrect responses
    d) Counted the number of correct and incorrect responses
    e) Timed how long it took to get them all right
    f) Other:_____

15) How did you record the child's performance?
    a) Did not record the child's performance
    b) Recorded the child's scores in a table

c) On a chart that I made myself
d) On the celeration chart used in training
e) Saved the marked probe sheet
f) Other:_____

16) When did you move on to a new set of teaching items?
a) After 8 days
b) Once the child had met their target
c) Once the child had met their target three times in a row
d) Every week
e) Other:_____

17) If the child had not made progress in three days what did you do?
a) Change the child's frequency targets
b) Change the child's error rate target
c) Change the number of items you taught
d) Change the teaching method
e) Choose easier teaching items
f) Other:_____

18) If the child did not hit their target in eight days what would you do?
a) Change child's targets
b) Change the number of items you taught
c) Change the teaching method
d) Add a motivating reward
e) Other:_____

Appendix K Interview Protocol

Interview Schedule

Researcher: Claudia Stubington

ERGO number: 47800

The following questions will be asked in the course of a semi-structured interview. Further questions may arise during the interview.

1. How has delivering the precision teaching intervention been?
2. Tell me how you go about each session.
3. Tell me about a time when it went well?
4. Tell me about a time that it didn't go well?
5. Tell me about how you delivered the precision teaching intervention?
6. Tell me about any adaptions you made to the precision teaching intervention?
7. What made you make these changes?
8. What barriers were there to delivering the precision teaching intervention?
9. What barriers were there to delivering the precision teaching intervention faithfully?
10. What did you do to overcome barriers?
11. What would you do differently next time?
12. Is there anything that school could have done to support you in delivering the precision teaching intervention?
13. Is there anything that I as the training deliverer could have done to support you in delivering the precision teaching intervention?
14. Is there anything else you would like to mention about delivering the intervention?
15. What was your favourite moment in delivering this precision teaching intervention?

Appendix L Updated questionnaire

1) For how many children have you delivered a precision teaching intervention at once?
    a) For a different child every time
    b) For one child delivered individually
    c) For multiple children delivered individually
    d) For multiple children delivered in a group
    e) For a whole class

2) For how times a week did you deliver the precision teaching program?
    a) Once a week
    b) Twice a week
    c) Three times a week
    d) Four times a week
    e) Five times a week

3) How did you decide where to focus your Precision Teaching program?
    a) Consulted with staff to discover the gaps in the child's knowledge
    b) Did a short test to find out what the child knows
    c) Chose key items from the curriculum that term
    d) Consulted with the child to see what they wanted to cover
    e) Other:_____

4) How many items did you teach at a time?
    a) 1-2
    b) 3-5
    c) 6-8
    d) 9-11
    e) Other:_____

5) What kind of targets did you set for the child to meet before they could move on to the next teaching items?
    a) Did not set targets
    b) The maximum number that they could get wrong
    c) The threshold number that they should get right

d) The maximum number that they could get wrong and the threshold number that they should get right
e) The target time for them to complete the probe sheet
f) Other:_____

6) What aim rates (the number of correct responses to the probe) did you use to set targets for see/hear to say probes?
(see/hear to say probes= responding verbally to a question or item asked or written down)
a) Not applicable - did not use see/hear to say probes*
b) Did not set aim rates
c) 15 items correct for infant pupils and 30 correct for juniors.
d) 40 items correct for infant pupils and 50 correct for juniors.
e) 60 items correct for infant pupils and 70 correct for juniors.
f) Individual aim rates based on measures of the child's fluency on known items
g) Other:_____

7) What minimum accuracy markers (the number of errors the child could make) did you use for see/hear to say probes?
(see/hear to say probes= responding verbally to a question or item asked or written down)
a) Not applicable - did not use see/hear to say probes*
b) Did not use minimum accuracy makers
c) 3 errors or less in a minute
d) 10 errors or less in a minute
e) Errors up to 10% of the fluency rate
f) Individual accuracy markers based on measures of the child's errors on known items.
g) Other:_____

8) What aim rates (the number of correct responses to the probe) did you use to set targets for see/hear to write probes?
(see/hear to write probes = responding in writing to a question or item asked or written down)
a) Not applicable - did not use see/hear to write probes*
b) Did not set aim rates
c) 15 items correct for infant pupils and 30 correct for juniors
d) 40 items correct for infant pupils and 50 correct for juniors
e) 60 items correct for infant pupils and 70 correct for juniors

f) Individual aim rates based on measures of the child's fluency on known items

g) Other:_____

9) What minimum accuracy markers did (the number of errors the child could make) you use for see/hear to write probes?
(see/hear to write probes = responding in writing to a question or item asked or written down)

a) Not applicable - did not use see/hear to write probes*

b) Did not use minimum accuracy makers

c) 3 errors or less in a minute

d) 10 errors or less in a minute

e) Errors up to 10% of the fluency rate

f) Individual accuracy markers based on measures of the child's errors on known items.

g) Other:_____

10) How long did you spend on the teaching section of the session?

a) Went straight to the probe

b) 3-5 minutes

c) 6-8 minutes

d) 9-11 minutes

e) Other:_____

11) What kind of teaching activity did you use?

a) Went through the probe sheet

b) A quick activity that gave the child feedback on each response

c) A quick activity that gave the child feedback at the end

d) Worked through each item and discussed it at length

e) Other:_____

12) How did you test the child's fluency?

a) Did not test the child's fluency

b) Repeating the teaching activity and scoring it

c) Using a probe grid

d) A quiz

e) Saying the items for the child to record in their spelling book

f) Other:_____

13) How long did your test last?
    a) Did not use a test
    b) As long as it took for the child to read all the probe items.
    c) 30 seconds
    d) 1 minute
    e) It varied according to the session
    f) Other:_____

14) How did you score the child's performance?
    a) Did not score the child's performance
    b) Counted the number of correct responses
    c) Counted the number of incorrect responses
    d) Counted the number of correct and incorrect responses
    e) Timed how long it took to get them all right
    f) Other:_____

15) How did you record the child's performance?
    a) Did not record the child's performance
    b) Recorded the child's scores in a table
    c) On a chart that I made myself
    d) On the celeration chart used in training
    e) Saved the marked probe sheet
    f) Other:_____

16) When did you move on to a new set of teaching items?
    a) After 8 days
    b) Once the child had met their target
    c) Once the child had met their target three times in a row
    d) Every week
    e) Other:_____

17) If the child had not made progress in three days what did you do?
    a) Change the child's frequency targets
    b) Change the child's error rate target
    c) Change the number of items you taught

d) Change the teaching method
e) Choose easier teaching items
f) Other:_____

18) If the child did not hit their target in eight days what would you do?
a) Change child's targets
b) Change the number of items you taught
c) Change the teaching method
d) Add a motivating reward
e) Other:_____

* please only select this option if you did not use this type of probe. If you did use this type of probe but did not use set minimum accuracy markers or aim rates please select option b.

Appendix M Ethics approval

ERGO II – Ethics and Research Governance Online https://www.ergo2.soton.ac.uk

Submission ID: 47800.A1
Submission Title: Understanding the barriers to fidelity in precision teaching interventions (Amendment 1)
Submitter Name: Claudia Stubington

Your submission has now been approved by the Faculty Ethics Committee. You can begin your research unless you are still awaiting any other reviews or conditions of your approval.

Comments:

-
-

Appendix N Headteacher Information and Consent Form

Head Teacher Information Sheet

Researcher: Claudia Stubington

ERGO number: 47800

Dear Head Teacher/insert name

I am writing to invite you to take part in a research study into factors that might help and hinder the delivery of a precision teaching intervention. To help you decide whether you would like to take part or not, it is important that you understand why the research is being done and what it will involve. Please read the information below carefully and ask questions if anything is not clear or you would like more information before you decide to take part in this research. You may like to discuss it with others but it is up to you to decide whether or not to take part. If you are happy to participate you will be asked to sign a consent form.

What is the research about?

The current study is being run by Claudia Stubington as part of her work towards her Doctorate of Educational Psychology. The Aim of the study is to gain a better understanding of the experiences of school staff delivering precision teaching interventions with a particular focus on the barriers to implementation. It is hoped that by developing our understanding in this area we can better design training and support for implementers to ensure that the intervention is delivered with the greatest chance of success**.**

Why has my school been asked to participate?

Your school is one of several from within the local authority which have been asked to participate. We hope to gain insight into the experiences of both teachers and TAs delivering the intervention.

What will happen if my school takes part?

Should you choose to allow your school to take part in this study, training on precision teaching delivered by a trainee educational psychologist will be offered to your staff. The training will take 90 minutes to two hours and can be delivered as a twilight or during the school day. This training will be free and will not take up any of your purchased SLA time.

Following training, staff who attended will be asked to deliver a precision teaching intervention. After X weeks of doing this, they will then be asked to complete a questionnaire detailing their

delivery of the intervention and asking them to consider how they would respond to hypothetical precision teaching scenarios.

Following completion of this questionnaire, the researcher might ask some of your staff to complete follow up interviews of their experience delivering the intervention. These interviews should take between one and one and a half hours and would be conducted during the school day. Audio recordings of all interviews will be made, transcribed and analysed to extract themes regarding participants' experience of the intervention and barriers that they experienced in delivering it. All participants will be asked to give written consent to participate and to be recorded. All data collected during this study will be stored securely in compliance with legal requirements.

In return for receiving this training in delivery of precision teaching interventions, we are asking your school to commit to ensuring that -

- At least three teachers who are interested in delivering the intervention attend the training (teaching assistants may also attended, but at least three teachers must attend).
- All staff who attend the training have the opportunity to deliver the intervention in the following two months.
- All staff who receive the training will be given the opportunity to complete a short questionnaire on their delivery of the intervention.
- Should members of your staff be selected for the follow up interview, they will be given the opportunity to take part at school and within school hours.

Are there any benefits in my taking part?

As part of your school taking part in this study, members of your staff will receive free training in the delivery of a precision teaching intervention. Furthermore, the findings of this study will be shared with the local authority and used to support the development of future training to ensure that it is tailored to maximise successful intervention delivery. Therefore, your school may benefit from future training that is adapted based on the findings of this study. A summary of the findings of this study will be made available to you and may support you to deliver future interventions with the maximum success.

Are there any risks involved?

As part of this study, members of your staff will be asked about their implementation of a precision teaching intervention. The researchers will not be providing any feedback about how they delivered the intervention. However, participants will be asked detailed questions that they might possibly find challenging to answer. We will make every effort to ensure that the experience of taking part in this study will be as positive as possible.

What data will be collected?

All school staff who take part in training will be asked to give their name, school, role and email address prior to training commencing.

Details regarding participant's delivery of the precision teaching intervention will be collected using a short written questionnaire. This questionnaire will ask participants to record their name and school. No other personal information will be collected.

During the final stage of this study some of the staff who receive training may be asked to take part in an interview about delivering the intervention. Audio recordings will be made of all interviews.

Will my school's data be confidential?

The information we collect about your school's staff during the course of the research will be kept strictly confidential.

Only members of the research team will have access to identifiable information and the intervention questionnaires. Identifiable information, ie consent forms will be stored securely in compliance with legal requirements. All other data, intervention questionnaires, interview recordings and interview transcripts, will be stored electronically and will be encrypted and password protected. Interview recordings will be destroyed immediately following transcription. Once transcription is complete all data will be fully anonymised.

A transcription service will be used to produce text transcripts of the interviews. As soon as possible after the interviews, the researcher will listen to the audio recordings and remove any identifiable data, for example surnames and names of schools. Therefore, identifiable information will be removed from the interview recordings before the transcription service is given access to them.

Responsible members of the University of Southampton may be given access to data about you for monitoring purposes and/or to carry out an audit of the study to ensure that the research is complying with applicable regulations. Individuals from regulatory authorities (people who check that we are carrying out the study correctly) may require access to your data. All of these people have a duty to keep your information, as a research participant, strictly confidential.

Does my school have to take part?

No, it is entirely up to you to decide whether your school takes part. If you decide you want to take part, you will need to sign a consent form to show you have agreed for your school to participate.

What happens if I change my mind?

You have the right to change your mind and cease participating at any time without giving a reason and without your participant rights being affected.

The data collected will be the property of the participant to whom it belongs until the point that it is fully anonymised. Therefore, it can only be withdrawn and destroyed at the request of the individual participant.

Should you wish to withdraw your school please contact Claudia Stubington (Email- c.m.stubington@soton.ac.uk)

What will happen to the results of the research?

Participant's personal details will remain strictly confidential. Research findings made available in any reports or publications will not include information that can directly identify your school without your specific consent.

Findings of the research will be shared with the local authority educational psychology services. Results will also be published in an academic journal; this will include anonymised quotes from interviews. An overall summary of the results will be made available to schools. Individual findings for specific schools or participants will not be shared.

Where can I get more information?

For further details regarding this study please contact Claudia Stubington (Email: c.m.stubington@soton.ac.uk)

What happens if there is a problem?

If you have a concern about any aspect of this study, you should speak to the researchers who will do their best to answer your questions. (Email: *c.m.stubington@soton.ac.uk*)

If you remain unhappy or have a complaint about any aspect of this study, please contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

Data Protection Privacy Notice

The University of Southampton conducts research to the highest standards of research integrity. As a publicly-funded organisation, the University has to ensure that it is in the public interest when we use personally-identifiable information about people who have agreed to take part in

research. This means that when you agree to take part in a research study, we will use information about you in the ways needed, and for the purposes specified, to conduct and complete the research project. Under data protection law, 'Personal data' means any information that relates to and is capable of identifying a living individual. The University's data protection policy governing the use of personal data by the University can be found on its website (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page).

This Participant Information Sheet tells you what data will be collected for this project and whether this includes any personal data. Please ask the research team if you have any questions or are unclear what data is being collected about you.

Our privacy notice for research participants provides more information on how the University of Southampton collects and uses your personal data when you take part in one of our research projects and can be found at http://www.southampton.ac.uk/assets/sharepoint/intranet/ls/Public/Research%20and%20Integrity%20Privacy%20Notice/Privacy%20Notice%20for%20Research%20Participants.pdf

Any personal data we collect in this study will be used only for the purposes of carrying out our research and will be handled according to the University's policies in line with data protection law. If any personal data is used from which you can be identified directly, it will not be disclosed to anyone else without your consent unless the University of Southampton is required by law to disclose it.

Data protection law requires us to have a valid legal reason ('lawful basis') to process and use your Personal data. The lawful basis for processing personal information in this research study is for the performance of a task carried out in the public interest. Personal data collected for research will not be used for any other purpose.

For the purposes of data protection law, the University of Southampton is the 'Data Controller' for this study, which means that we are responsible for looking after your information and using it properly. The University of Southampton will keep identifiable information about you for 10 years after the study has finished after which time any link between you and your information will be removed.

To safeguard your rights, we will use the minimum personal data necessary to achieve our research study objectives. Your data protection rights – such as to access, change, or transfer such information - may be limited, however, in order for the research output to be reliable and accurate. The University will not do anything with your personal data that you would not reasonably expect.

If you have any questions about how your personal data is used, or wish to exercise any of your rights, please consult the University's data protection webpage (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page) where you can make a request using our online form. If you need further assistance, please contact the University's Data Protection Officer (data.protection@soton.ac.uk).

Prior to Transcription of the interviews, all data will be stored pseudo-anonymously. It will be stored under unique participant identification codes. Identifiable information will be stored securely and separately from pseudo-anonymised information. Following, transcription all data will be fully anonymised.

Thank you for taking the time to read the information sheet and considering taking part in our research.

HEAD TEACHER CONSENT FORM

Researcher name: Claudia Stubington

ERGO number: 47800

Please initial the box(es) if you agree with the statement(s):

I have read and understood the information sheet [version 1] and have had the opportunity to ask questions about the study.	
I agree to allow my school to take part in this research project.	
I understand my school's participation is voluntary and I may withdraw at any time.	
I understand that should I choose to withdraw my school the data already collected will continue to be used unless its withdrawal is requested by the individual participant it relates to.	
I understand that data from staff at my school may be quoted directly in reports of the research but that individual participants will not be directly identified (e.g. that names will not be used).	

Appendix O

Name of school ……..

Name of Head Teacher (print name)……

Signature of Head Teacher …….

Date……. ……

Name of researcher (print name)……

Signature of researcher …….

Date……..

Appendix O Participant Information and Consent Forms

Individual Participant Information Sheet

Researcher: Claudia Stubington

ERGO number: 47800

You are being invited to take part in a study into factors that might help and hinder the delivery of a precision teaching intervention. To help you decide whether you would like to take part or not, it is important that you understand why the research is being done and what it will involve. Please read the information below carefully and ask questions if anything is not clear or you would like more information before you decide to take part in this research. You may like to discuss it with others but it is up to you to decide whether or not to take part. If you are happy to participate you will be asked to sign a consent form.

What is the research about?

The current study is being run by Claudia Stubington as part of her work towards her Doctorate of Educational Psychology. The Aim of the study is to gain a better understanding of the experiences of school staff delivering precision teaching interventions with a particular focus on the barriers to implementation. It is hoped that by developing our understanding in this area we can better design training and support for implementers to ensure that the intervention is delivered with the greatest chance of success**.**

Why have I been asked to participate?

Your school is one of several from within the local authority which have been asked to participate. We hope to gain insight into the experiences of both teachers and TAs delivering the intervention. You have been put forward by your school as a possible candidate to participate in this research.

What will happen to me if I take part?

Should you choose to take part in this study you will receive training on the precision teaching intervention delivered by a trainee educational psychologist. The training will take 90 minutes to two hours and will be delivered as a twilight or during the school day. During this training you will gain an understanding of the theory and practical delivery of precision teaching.

Following training, you will be asked to deliver the intervention at your school within your teaching or teaching assistant role. After X weeks of doing this, you will then be asked to complete a short questionnaire detailing your delivery of the precision teaching intervention. This

questionnaire will include questions about the length of time you have delivered the intervention for and how many children you have used it with. It will also include questions which outline an example situation in relation to the intervention and ask how you might respond to it..

Following completion of this questionnaire, the researcher might ask to come and talk to you individually about your experience of delivering the intervention. These conversations should take between one and one and a half hours and would be conducted during the school day at your school. Audio recordings will be taken, transcribed and analysed to extract themes regarding yours and the other participants' experience of delivering the precision teaching intervention and the factors which helped and hindered this.

All participants will be asked to give written consent to take part in this study and to be recorded. All data will be stored securely in accordance with legal requirements.

Are there any benefits in my taking part?

As part of this study, you will receive training from a trainee educational psychologist in delivering an precision teaching intervention. The findings of this study will be shared with the local authority and could be used to develop more effective future training to ensure that it is tailored to maximise successful intervention delivery. Therefore, your school may benefit from future training that is adapted based on the findings of this study. Your school will also receive general feedback on the factors which can affect implementing the intervention which they may be able to use to better support you delivering it in future. This feedback will be a summary of all findings from across several different schools and will not be specific to you.

Are there any risks involved?

As part of this study you will be asked about your implementation of a precision teaching intervention. The researchers will not be providing any feedback to you about how you delivered the intervention. However, you will be asked detailed questions that you might possibly find challenging to answer. We will make every effort to ensure that the experience of taking part in this study will be as positive as possible.

What data will be collected?

All school staff who take part in training will be asked to give their name, school, role and email address prior to training commencing.

Details regarding your delivery of the intervention will be collected using a written questionnaire. This questionnaire will ask participants to record their name and school. No other personal information will be collected.

During the final stage of this study you may be asked to take part in an conversation about delivering the intervention. Audio recordings will be made.

Will what I say be confidential?

The information we collect about you during the course of the research will be kept strictly confidential.

Only members of the research team will have access to identifiable information and the intervention questionnaires. Identifiable information - ie, consent forms - will be stored securely in compliance with legal requirements. All other data, intervention questionnaires, audio recordings and transcripts, will be stored electronically and will be encrypted and password protected. Audio recordings will be destroyed immediately following transcription. Once transcription is complete, all data will be fully anonymised: this means that no individual response in the data can be linked to you or any other specific individual from this point on.

A transcription service will be used to produce text transcripts of the interviews. During interviews, you will be asked to avoid using names such as your name, the name of a colleague or the name of the school, however, as soon as possible after the interviews, the researcher will listen to the audio recordings and remove any identifiable data which does get spoken. Therefore, identifiable information will be removed from the interview recordings before the transcription service is given access to them.

Responsible members of the research team at the University of Southampton may be given access to data about you for monitoring purposes and/or to carry out an audit of the study to ensure that the research is complying with applicable regulations. Individuals from regulatory authorities (people who check that we are carrying out the study correctly) may require access to your data. All of these people have a duty to keep your information, as a research participant, strictly confidential.

Do I have to take part?

No, it is entirely up to you to decide whether you take part. If you decide you want to take part, you will need to sign a consent form to show you have agreed.

What happens if I change my mind?

You have the right to change your mind and withdraw at any time prior to the completion of interview transcription without giving a reason and without your participant rights being affected. Following transcription of the interviews, however, all data will be fully anonymised and we will no longer be able to identify your data for removal.

Should you wish to withdraw please contact Claudia Stubington (Email- c.m.stubington@soton.ac.uk)

What will happen to the results of the research?

Your personal details will remain strictly confidential. Research findings made available in any reports or publications will not include information that can directly identify you without your specific consent.

Findings of the research will be shared with the local authority educational psychology services. The intention is that results will also be published in an academic journal; this will include anonymised quotes from interviews. An overall summary of the results will be made available to schools. Individual findings for specific schools or participants will not be shared.

Where can I get more information?

For further details regarding this study please contact Claudia Stubington (Email: c.m.stubington@soton.ac.uk)

What happens if there is a problem?

If you have a concern about any aspect of this study, you should speak to the researchers who will do their best to answer your questions. (Email: *c.m.stubington@soton.ac.uk)*

If you remain unhappy or have a complaint about any aspect of this study, please contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

Data Protection Privacy Notice

The University of Southampton conducts research to the highest standards of research integrity. As a publicly-funded organisation, the University has to ensure that it is in the public interest when we use personally-identifiable information about people who have agreed to take part in research. This means that when you agree to take part in a research study, we will use information about you in the ways needed, and for the purposes specified, to conduct and complete the research project. Under data protection law, 'Personal data' means any information

that relates to and is capable of identifying a living individual. The University's data protection policy governing the use of personal data by the University can be found on its website (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page).

This Participant Information Sheet tells you what data will be collected for this project and whether this includes any personal data. Please ask the research team if you have any questions or are unclear what data is being collected about you.

Our privacy notice for research participants provides more information on how the University of Southampton collects and uses your personal data when you take part in one of our research projects and can be found at http://www.southampton.ac.uk/assets/sharepoint/intranet/ls/Public/Research%20and%20Integrity%20Privacy%20Notice/Privacy%20Notice%20for%20Research%20Participants.pdf

Any personal data we collect in this study will be used only for the purposes of carrying out our research and will be handled according to the University's policies in line with data protection law. If any personal data is used from which you can be identified directly, it will not be disclosed to anyone else without your consent unless the University of Southampton is required by law to disclose it.

Data protection law requires us to have a valid legal reason ('lawful basis') to process and use your Personal data. The lawful basis for processing personal information in this research study is for the performance of a task carried out in the public interest. Personal data collected for research will not be used for any other purpose.

For the purposes of data protection law, the University of Southampton is the 'Data Controller' for this study, which means that we are responsible for looking after your information and using it properly. The University of Southampton will keep identifiable information about you for 10 years after the study has finished after which time any link between you and your information will be removed.

To safeguard your rights, we will use the minimum personal data necessary to achieve our research study objectives. Your data protection rights – such as to access, change, or transfer such information - may be limited, however, in order for the research output to be reliable and accurate. The University will not do anything with your personal data that you would not reasonably expect.

If you have any questions about how your personal data is used, or wish to exercise any of your rights, please consult the University's data protection webpage (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page) where you can make a request using our online form. If you need further assistance, please contact the University's Data Protection Officer (data.protection@soton.ac.uk).

Prior to Transcription of the interviews, all data will be stored pseudo-anonymously. It will be stored under unique participant identification codes. Identifiable information will be stored securely and separately from pseudo-anonymised information. Following, transcription all data will be fully anonymised.

Thank you for taking the time to read the information sheet and considering taking part in our research.

CONSENT FORM

Researcher name: Claudia Stubington

ERGO number: 47800

Please initial the box(es) if you agree with the statement(s):

I have read and understood the information sheet [Version 1] and have had the opportunity to ask questions about the study.	
I agree to take part in this research project and agree for my data to be used for the purpose of this study.	
I understand my participation is voluntary and I may withdraw at any time for any reason without my participation rights being affected.	
I understand that if I withdraw from the study that it may not be possible to remove the data once my personal information is no longer linked to the data.	

I understand that I may be quoted directly in reports of the research but that I will not be directly identified (e.g. that my name will not be used).	
I agree to take part in the interview for the purposes set out in the participation information sheet and understand that these will be recorded using audio recording.	
I understand that my personal information collected about me such as my name or the school I work at will not be shared beyond the study team.	

Name of participant (print name)……

Signature of participant…….

Date…….. ……..

Email……

Name of researcher (print name)……

Signature of researcher …….

Date……..

Appendix P Participant Debrief Sheet

Understanding the barriers to fidelity in precision teaching interventions

Debriefing Statement

ERGO No.: 47800

Name of Researcher: Claudia Stubington

Research has shown that precision teaching interventions delivered in schools are often adapted, with core elements altered or omitted. These alterations can lessen the impact of precision teaching. The aim of this research was to understand the factors that lead to precision teaching interventions being adapted as well as factors that might help in delivering the intervention faithfully. Your data will help our understanding of what can lead to changes being made to precision teaching interventions. The experiment did not previously mention that faithfulness to the intervention was the primary area of interest. This information was omitted because we wanted to understand why changes were happening. We were concerned that if we highlighted change as an area of interest it might have effected what adaptions were made and why.

Once again, results of this study will not include your name or any other identifying characteristics. When the research is complete, a summary of the findings will be shared with your school.

If you have any further questions please contact me at c.m.stubington@soton.ac.uk.

Thank you for your participation in this research.

Signature _____ Date _____

Name

If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

List of References

Alper, T. G., & White, O. R. (1971). Precision Teaching: A tool for the school psychologist and teacher. *Journal of School Psychology, 9*(4), 445-454.

Arno, A., & Thomas, S. (2016). The efficacy of nudge theory strategies in influencing adult dietary behaviour: a systematic review and meta-analysis. *BMC public health, 16*(1), 1-11.

Baldwin, T. T., Ford, J. K., & Blume, B. D. (2009). Transfer of training 1988–2008: An updated review and agenda for future research. *International review of industrial and organizational psychology, 24*(1), 41-70.

Bauman, L. J., Stein, R. E., & Ireys, H. T. (1991). Reinventing fidelity: The transfer of social technology among settings. *American journal of community psychology, 19*(4), 619-639.

Baumgartel, H. J., Reynolds, J. I., & Pathan, R. Z. (1984). How personality and organisational climate variables moderate the effectiveness of management development programmes: A review and some recent research findings. *Management & Labour Studies*.

Bauer, M. S., Damschroder, L., Hagedorn, H., Smith, J., & Kilbourne, A. M. (2015). An introduction to implementation science for the non-specialist. *BMC psychology*, *3*(1), 1-12.

Boys, A., & Lyndon, S. (2008). The origins of precision teaching: An overview of existing research. *Debate, 126*, 23-28.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology, 3*(2), 77-101.

Braun, V., & Clarke, V. (2016). (Mis) conceptualising themes, thematic analysis, and other problems with Fugard and Potts'(2015) sample-size tool for thematic analysis. *International journal of social research methodology, 19*(6), 739-743.

Braun, V., & Clarke, V. (2020). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative research in psychology*, 1-25.

Braun, V., Clarke, V., Hayfield, N., & Terry, G. (2019). Thematic Analysis. In P. Liamputtong (Ed.), *Handbook of Research Methods in Health Social Sciences* (pp. 843-860). Singapore: Springer Singapore.

Brooks, G. (2013). What works for children and young people with literacy difficulties. *The effectiveness of intervention schemes*.

Browder, D. M., Trela, K., & Jimenez, B. (2007). Training teachers to follow a task analysis to engage middle school students with moderate and severe developmental disabilities in grade-appropriate literature. *Focus on Autism and Other Developmental Disabilities, 22*(4), 206-219.

Burke, L. A., & Hutchins, H. M. (2007). Training transfer: An integrative literature review. *Human resource development review, 6*(3), 263-296.

Carbo, M., & Cole, R. W. (1995). What Every Principal Should Know about Teaching Reading. *Instructional Leader, 8*(1), 1.

Chiesa, M., & Robertson, A. (2000). Precision teaching and fluency training: Making maths easier for pupils and teachers. *Educational Psychology in Practice, 16*(3), 297-310.

Cline, T., & Frederickson, N. (2009). *Special educational needs, inclusion and diversity*: McGraw-Hill Education (UK).

Cook, B. G., & Cook, S. C. (2013). Unraveling evidence-based practices in special education. *The Journal of Special Education, 47*(2), 71-82.

Cree, A., Kay, A., & Steward, J. (2012). The economic and social cost of illiteracy: A snapshot of illiteracy in a global context. *World Literacy Foundation*.

Daly, P. M., & Cooper, J. O. (1993). Persuading student teachers and inservice teachers to use precision teaching after the course is over. *Education and Treatment of Children*, 316-325.

Daniel, J., & Lemons, C. (2018). Teacher perspectives on intervention sustainability: implications for school leadership. *School Leadership & Management, 38*(5), 518-538.

Davenport, C. A., Alber-Morgan, S. R., & Konrad, M. (2019). Effects of behavioral skills training on teacher implementation of a reading racetrack intervention. *Education & treatment of children, 42*(3), 385.

Downer, A. C. (2007). The national literacy strategy sight recognition programme implemented by teaching assistants: A precision teaching approach. *Educational Psychology in Practice, 23*(2), 129-143.

Department for Education(2014). *he national curriculum in England: complete framework for key stages 1 to 4*. Retrieved from https://www.gov.uk/government/publications/national-curriculum-in-england-framework-for-key-stages-1-to-4

Education, D. f. (2020). Education, skills and training. Retrieved from https://www.ethnicity-facts-figures.service.gov.uk/education-skills-and-training

Ekström, M. (1992). Causal explanation of social action: the contribution of Max Weber and of critical realism to a generative view of causal explanation in social science. *Acta Sociologica, 35*(2), 107-122.

Engelmann, S., Carnine, L., & Johnson, G. (1999). Corrective reading. *Word Attack Basics, Decoding A*.

Erbey, R., McLaughlin, T., Derby, K. M., & Everson, M. (2011). The effects of using flashcards with reading racetrack to teach letter sounds, sight words, and math facts to elementary students with learning disabilities. *International Electronic Journal of Elementary Education, 3*(3), 213-226.

Fletcher, A. J. (2017). Applying critical realism in qualitative research: methodology meets method. *International journal of social research methodology, 20*(2), 181-194.

Fransman, J. (2005). Understanding literacy: A concept paper. *The EFA Global Monitoring Report, Literacy for Life, 31*.

Fuchs, D., Fuchs, L. S., Otaiba, S. A., Thompson, A., Yen, L., Mcmaster, K. N., . . . Yang, N. J. (2001). K-PALS Helping Kindergartners with reading readiness: Teachers and researchers in partnerships. *Teaching Exceptional Children, 33*(4), 76-80.

Gallagher, E., Bones, R., & Lombe, J. (2006). Precision teaching and education: Is fluency the missing link between success and failure? *Irish Educational Studies, 25*(01), 93-105.

Givens, A., Francis, A. M., Wilson, A. B., Parisi, A., Phillips, J., & Villodas, M. (2021). Accountability in Intervention Research: Developing a Fidelity Checklist of a Mental Health Intervention in Prisons. *Community mental health journal*, 1-12.

Griffin, C. P., & Murtagh, L. (2015). Increasing the sight vocabulary and reading fluency of children requiring reading support: The use of a Precision Teaching approach. *Educational Psychology in Practice, 31*(2), 186-209.

Hanley, S., Ringwalt, C., Vincus, A. A., Ennett, S. T., Bowling, J. M., Haws, S. W., & Rohrbach, L. A. (2009). Implementing evidence-based substance use prevention curricula with fidelity: The role of teacher training. *Journal of drug education, 39*(1), 39-58.

Haring, N., Lovitt, T., Eaton, M., & Hansen, C. (1978). The fourth R: Research in the classroom. Columbus, OH: Charles E. In: Merrill Publishing Co.

Higgins, S., Katsipataki, M., Villanueva-Aguilera, A., Coleman, R., Henderson, P., Major, L., . . . Mason, D. (2016). The Sutton Trust-Education Endowment Foundation Teaching and Learning Toolkit.

Hulleman, C. S., & Cordray, D. S. (2009). Moving from the lab to the field: The role of fidelity and achieved relative intervention strength. *Journal of Research on Educational Effectiveness, 2*(1), 88-110.

Kim, W., Linan-Thompson, S., & Misquitta, R. (2012). Critical factors in reading comprehension instruction for students with learning disabilities: A research synthesis. *Learning Disabilities Research & Practice, 27*(2), 66-78.

Klem, A. M., & Connell, J. P. (2004). Relationships matter: Linking teacher support to student engagement and achievement. *Journal of school health, 74*, 262-273.

Lambe, D., Murphy, C., & Kelly, M. E. (2015). The impact of a precision teaching intervention on the reading fluency of typically developing children. *Behavioral interventions, 30*(4), 364-377.

Voyager Expanded Learning, (2004). *Voyager Universal Literacy System [Brochure]*. Dallas, TX.

Lindsley, O. R. (1991). Precision teaching's unique legacy from BF Skinner. *Journal of Behavioral Education, 1*(2), 253-266.

Lindsley, O. R. (1992). Precision teaching: Discoveries and effects. *Journal of Applied Behavior Analysis, 25*(1), 51.

Longhurst, R. (2003). Semi-structured interviews and focus groups. *Key methods in geography, 3*(2), 143-156.

Main, S., Backhouse, M., Jackson, R., & Hill, S. (2020). Mitigating reading failure in adolescents: Outcomes of a Direct Instruction reading programme in one secondary school. *Australian Journal of Language and Literacy, The, 43*(2), 152-166.

McIntyre, E., Powell, R., Coots, K. B., Jones, D., Powers, S., Deeters, F., & Petrosko, J. (2005). Reading Instruction in the NCLB Era: Teachers' Implementation Fidelity of Early Reading Models. *Journal of Educational Research & Policy Studies, 5*(2), 66-102.

O'Keeffe, B. V., Slocum, T. A., & Magnusson, R. (2013). The effects of a fluency training package on paraprofessionals' presentation of a reading intervention. *The Journal of Special Education, 47*(1), 14-27.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and policy in mental health and mental health services research, 42*(5), 533-544.

Potts, L., Eshleman, J. W., & Cooper, J. O. (1993). Ogden R. Lindsley and the historical development of precision teaching. *The Behavior Analyst, 16*(2), 177-189.

Ramey, D., Lydon, S., Healy, O., McCoy, A., Holloway, J., & Mulhern, T. (2016). A systematic review of the effectiveness of precision teaching for individuals with developmental disabilities. *Review Journal of Autism and Developmental Disorders, 3*(3), 179-195.

Raybould, E., & Solity, J. (1988). More questions on precision teaching. *British Journal of Special Education, 15*(2), 59-61.

Reichow, B., Volkmar, F. R., & Cicchetti, D. V. (2008). Development of the evaluative method for evaluating and determining evidence-based practices in autism. *Journal of autism and developmental disorders, 38*(7), 1311-1319.

Ringwalt, C. L., Ennett, S., Johnson, R., Rohrbach, L. A., Simons-Rudolph, A., Vincus, A., & Thorne, J. (2003). Factors associated with fidelity to substance use prevention curriculum guides in the nation's middle schools. *Health Education & Behavior, 30*(3), 375-391.

Roberts, C. A., & Leko, M. M. (2013). Integrating functional and academic goals into literacy instruction for adolescents with significant cognitive disabilities through shared story reading. *Research and Practice for Persons with Severe Disabilities, 38*(3), 157-172.

Roberts, W., & Norwich, B. (2010). Using precision teaching to enhance the word reading skills and academic self-concept of secondary school students: a role for professional educational psychologists. *Educational Psychology in Practice, 26*(3), 279-298.

Rohrbach, L. A., Graham, J. W., & Hansen, W. B. (1993). Diffusion of a school-based substance abuse prevention program: Predictors of programme implementation. *Preventive medicine, 22*(2), 237-260.

Rose, T. L., & Sherry, L. (1984). Relative effects of two previewing procedures on LD adolescents' oral reading performance. *Learning Disability Quarterly, 7*(1), 39-44.

Samuels, S. J. (1979). The method of repeated readings. *The reading teacher, 32*(4), 403-408.

Santacroce, S. J., Maccarelli, L. M., & Grey, M. (2004). Intervention fidelity. *Nursing research, 53*(1), 63-66.

Simpson, R. L., LaCava, P. G., & Sampson Graner, P. (2004). The no child left behind act: Challenges and implications for educators. *Intervention in school and clinic, 40*(2), 67-75.

Solity, J., & Bull, S. (1987). *Special needs: Bridging the curriculum gap*: Open University Press.

Starlin, A. H. (1986). *Survey of fifteen principals trained in Precision Teaching exploring their use of the standard celeration Chart.* University of Kansas,

Stein, M. L., Berends, M., Fuchs, D., McMaster, K., Sáenz, L., Yen, L., . . . Compton, D. L. (2008). Scaling up an early reading program: Relationships among teacher support, fidelity of implementation, and student performance across different sites and years. *Educational Evaluation and Policy Analysis, 30*(4), 368-388.

Sundhu, R., & Kittles, M. (2016). Precision teaching: does training by educational psychologist have an impact? *Educational Psychology in Practice, 32*(1), 13-23.

Swanson, E., Wanzek, J., Haring, C., Ciullo, S., & McCulley, L. (2013). Intervention fidelity in special and general education research journals. *The Journal of Special Education*, *47*(1), 3-13.

Tancredo, D. E. (2001). The Effects of Breakthrough to Literacy on Oral Language Development at the Kindergarten Level.

Tyng, C. M., Amin, H. U., Saad, M. N., & Malik, A. S. (2017). The influences of emotion on learning and memory. *Frontiers in psychology, 8*, 1454.

Tziner, A., Haccoun, R. R., & Kadish, A. (1991). Personal and situational characteristics influencing the effectiveness of transfer of training improvement strategies. *Journal of occupational psychology, 64*(2), 167-177.

Vernon-Feagans, L., Amendum, S., Kainz, K., & Ginsburg, M. (2009). The Targeted Reading Intervention (TRI): A Classroom Teacher Tier 2 Intervention to Help Struggling Readers in Early Elementary School. *Society for Research on Educational Effectiveness*.

Vernon-Feagans, L., Bratsch-Hines, M., Varghese, C., Bean, A., & Hedrick, A. (2015). The Targeted Reading Intervention: Face-to-face vs. webcam literacy coaching of classroom teachers. *Learning Disabilities Research & Practice, 30*(3), 135-147.

Vygotsky, L. S. (1987). *The collected works of LS Vygotsky: The fundamentals of defectology* (Vol. 2): Springer Science & Business Media.

Wagner, D. A. (2011). What happened to literacy? Historical and conceptual perspectives on literacy in UNESCO. *International Journal of Educational Development, 31*(3), 319-323.

Webster, R., Russell, A., & Blatchford, P. (2015). *Maximising the impact of teaching assistants: Guidance for school leaders and teachers*: Routledge.

Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. *Child development, 69*(3), 848-872.

Whiting, L. S. (2008). Semi-structured interviews: Guidance for novice researchers. *Nursing standard, 22*(23).

Zimmerman, S. S., Rodriguez, M. C., Rewey, K. L., & Heidemann, S. L. (2008). The impact of an early literacy initiative on the long term academic success of diverse students. *Journal of Education for Students Placed at Risk, 13*(4), 452-481.

Zoder-Martell, K., Dufrene, B., Sterling, H., Tingstrom, D., Blaze, J., Duncan, N., & Harpole, L. (2013). Effects of verbal and graphed feedback on treatment integrity. *Journal of Applied School Psychology, 29*(4), 328-349.

Zvoch, K. (2009). Treatment fidelity in multisite evaluation: A multilevel longitudinal examination of provider adherence status and change. *American Journal of Evaluation, 30*(1), 44-61.