# *Improving Essential Numeracy Skills in Primary Schoolchildren Using a Brief Fluency-building Intervention: A Randomised Control Trial*

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ABSTRACT

Numeracy skills are essential if children are to succeed academically. We investigated the efficacy of short fluency-building exercises to target a number of essential numeracy skills (writing digits and simple addition problems). We further wanted to ascertain whether such an intervention would impact their ability to solve related but unpractised subtraction problems. Children from two mainstream primary schools (aged 9–10) were allocated randomly to either a fluency-building intervention group (FBI; n = 19) or a control group (C; n = 10). The intervention group engaged in daily fluency-building practice that consisted of writing and reciting essential numeracy facts. The control group children received their standard instruction. The study took place over five weeks; following the intervention, the children in the FBI group performed significantly better ($p < .05$) on three of the four numeracy elements with large effect sizes (d = 1.25–1.67). Results are discussed in the context of incorporating simple essential skills fluency-building exercises into mainstream classes, and how the implementation need not be costly in terms of staff time or resources.

**Key words:** essential numeracy skills; basic skills; fluency-building procedures; Reliable Change Index (RCI); Number Needed to Treat (NNT).

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Deficits in essential skills have been demonstrated to have serious implications for an individual's future success. For example, Parsons (2002) conducted a UK longitudinal survey the results of which indicated that poor literacy or numeracy skills directly increased the likelihood of future offending. Additionally, recent reports highlight that the general standard of basic skills has declined significantly over the past few years when compared to the performance of children in other countries. Across Europe, deficits in literacy and numeracy skills have been identified, and typical recommendations focus on more use of learning and instructional practices that can increase levels of achievement whilst also reducing individual variation in performance (Organisation Economic Co-operation and Development (OECD), 2010, 2015).

More recently (in Wales) reports have highlighted not only the future direction that the education system should take in order to become more effective for every learner (Donaldson, 2015a), but also the pivotal role that basic skills play in any educational curriculum. As Donaldson asserts 'Literacy and numeracy are universally acknowledged to be the essential foundations of education' (2015b: 19). Furthermore, it is vital that educators use programmes and procedures that have a reliable and tested evidence base in their teaching, and that they monitor the effectiveness of programmes as part of their normal instructional and classroom management routines.

Specifically, in regard to numeracy skills, Slavin and Lake (2008) conducted a meta-analysis of eighty-seven studies (thirty-six of which used random assignment to intervention groups) to ascertain which type of teaching approach is most beneficial in helping children learn maths skills. From their analysis, Slavin and Lake generated three categories of maths approaches: curriculum changes, supplementing curricular with computer assisted instruction (CAI) and changes in classroom practices (both in terms of instruction and classroom management). Slavin and Lake concluded that the evidence strongly supports changes in classroom practices as most likely to be effective compared with changes in either technology or curricula alone. The evidence reviewed suggested that instructional practices and learning strategies that can be easily implemented in mainstream educational settings may be particularly effective.

There are a number of principles of effective educational practice that increase the likelihood of successful learning in the classroom, such as ensuring competent models, high active responding from the learner, immediate feedback, mastery learning and motivational environments

(Fredrick and Hummel, 2004; Binder, 2003, 1996; Ericsson et al., 1993; US Department of Education, 2009). Additionally, a valid system of monitoring whether individual children are achieving planned gains in learning objectives has proven to be essential (Lindsley, 1995; Fuchs, 2004).

With regard to the second point above, most schools in the UK are required to administer standardised tests at set times throughout a child's education. These assessments are typically used to compare their performance with that of their peers and thus monitor their progress. However, these tests are too infrequent to guide meaningful change in the delivery of the curriculum (Fuchs and Fuchs, 1993; Fuchs, 2004; Johnson and Layng, 1994; Johnson, 2008). To monitor individual progress, measurements of learning must be taken more regularly, and educators need to be trained to be able to use this information to rapidly react and adapt to each child's individual needs (Fuchs and Fuchs, 1993; Lindsley, 2010; White, 2000; West et al., 1990; Reynolds and Shaywitz, 2009; National Centre for Response to Intervention, 2010).

There are a number of different approaches that measure learning more frequently to monitor individual academic progress for all learners (White, 2002; Vaughn et al., 2008; Reynolds and Shaywitz, 2009; Bramlett et al., 2010; Moors, 2010). Response to Intervention (RtI) is implemented using a three-level system that consists of primary (Tier 1), secondary (Tier 2) and tertiary (Tier 3) interventions (National Centre for Response to Intervention, 2010). A similar graduated response approach has also been introduced in the UK to provide more intensive literacy and numeracy interventions for children according to their need (DfEE, 1999; Dowker, 2009; Department for Education and Skills, 2001). RtI has a growing evidence base (Reynolds and Shaywitz, 2009; White, 2002; Moors, 2010) and is similar in some key ways to other approaches to measuring learning that have been used successfully within academic settings and have a long and growing evidence base, such as Curriculum-based Measurement (CBM) and Precision Teaching (PT).

Within a CBM approach (Deno et al., 2001; Fuchs, 2004) measures of academic improvement are taken at least monthly, and proponents of PT typically use daily measurements as indices of improvement (Alper and White, 1971; Binder, 1990; White, 2000; Johnson, 2008). All three (RtI, CBM and PT) approaches, irrespective of the frequency at which they are administered, can act as efficient 'academic thermometers' (Shinn and Barmonto, 1997) to monitor each child's progress within a specific curriculum domain (e.g. maths). Although there is little research directly comparing the relative efficacy of these approaches (Binder, 1990; Fuchs, 2004), the more regular measurements provided by the PT approach and the recording of these measurements on a Standard Celeration Chart (SCC) has been shown to provide motivational feedback to learners, especially when they are taught to record and chart their own learning (Lindsley, 1995; Bower, 1985).

PT is a measuring system that helps teachers ensure that *every child in a class* maintains rapid and successful learning. This approach has had considerable success across a number of educational settings and academic areas, with children in mainstream schools (Beck and Clement, 1991; Miller and Calkin, 1997; Chiesa and Robertson, 2000; Hughes et al., 2007), undergraduate students (Beverley et al., 2009), children with autism (Zambolin et al., 2004; Kubina et al., 2002; Kubina and Wolf, 2005; Kerr et al., 2003) and other special educational needs (Solis et al., 2003). Combined with regular teaching, PT can represent a powerful accelerated learning approach, when effectively amalgamated with other evidenced-based methods of instruction (such as Direct Instruction) to provide highly effective learning environments (Binder and Watkins, 1990; Binder, 1990; Sante et al., 2001; Morelle et al., 1995; Kubina et al., 2009). One key aspect of the PT approach is to encourage students to build fluent performances in essential skills. Previous studies have successfully used these approaches to improve individual maths performance; however, most of these were restricted to small *n* designs (Raggio and Bitgood, 1982; Sweeney et al., 2001; Hayden and McLaughlin, 2004). Two previous studies did apply these PT strategies and tactics in a more traditional group study design with successful outcomes (Fitzgerald and Garcia, 2006; Chiesa and Robertson, 2000).

Chiesa and Robertson (2000) investigated the effects of a brief fluency-building with elements of long division over a twelve-week period. The intervention group only practised elements of long division rather than fully completing long-division problems. In contrast, all of the children in the control group had spent time fully completing long-division problems. Children in the intervention group outperformed all but one of their peers on tests of long division.

In the present study, we have explored the effect of a brief intervention targeting fluency-building of essential numeracy skills in the intervention group, measuring each child's daily improvement as would be typically done within a PT framework. We examined whether student performance on basic numeracy facts (components) would influence their performance on the post-test (composite) in comparison with a control group, which received the standard mathematics instruction. Furthermore, we tested for effects beyond the areas practised to provide support for the emergence of novel composite skills, which are reliant on the fluent performance of prerequisite component tasks.

## *Method*

### *Participants and setting*

Mainstream schools in the local area were approached to see if they wished to take part in research on essential numeracy skills. From the schools approached, two schools agreed to take part. The study took place in these two mainstream primary schools in north Wales, UK. Twenty-nine children (aged 9–10) who had been identified by their class teachers to be struggling with maths were eligible to take part in the study. Nineteen of these children were allocated randomly (using weighted randomised selection based on a 2:1 model) to the fluency-building intervention group (FBI; females = 12, males = 7), and ten were allocated to the control group (C; female = 6, males = 4). Because all children selected were struggling in numeracy skills – and the school specifically wanted as many children as possible to take part in the initial intervention – we randomised a larger proportion of children to the intervention group. The criteria used by teachers for children's inclusion in the study was the children's performance on the usual standardised annual achievement tests administered within the school, as well as individual classroom performance data. All of the children were typically developing, and none had any identified special educational needs.

### *Apparatus and materials*

Standard worksheets were used for both pre- and post-tests. The tests were used to pinpoint the instructional level for each child and to allow later comparisons following the intervention. The content was taken from the maths curriculum but the practice sheets and flashcards were designed to build basic component skills to fluency. Each worksheet contained more maths problems than any child could complete in the timing period to ensure that no artificial ceiling was placed on their performance. Each

**Table 1. Details and description of each skill and its associated AIM for the treatment group (PT) during the brief intervention.**

| *Pre- and post-test essential skills tested* | *Description* | *AIM per minute* | *Examples of skill order* |
|---|---|---|---|
| 1] Writing numbers | Digits 0–9 written in a continuous stream. | 120–100 digits written correctly with ≤ 2 errors | Writing single digits 0–9. Writing double digits 10–19, etc. |
| 2] Single digit addition with answers of ≤ 10. | Computation of single plus single digit addition problems | 80–60 correct answers with ≤ 2 errors | Adding digits with answers of < 10. |
| 3] Single digit addition problems with answers of ≥ 10 and ≤ 19. | *Computation of single plus single (or double) digit addition problems | 80–60 correct answers with ≤ 2 errors | Adding digits with answers of > 10 but ≤ 19, etc. |
| 4] Single digit subtraction problems with answers between 0–6 | * | | |

*Note:* An * in the description column denotes skills that were never practised during the intervention.

worksheet covered one of four levels of numeracy problems (see Table 1). The same types of worksheets were used to generate random practice sheets for use during the individual intervention periods. However, only the first two skill levels were practised during the intervention (see Table 1; the intervention group did not practise subtraction at any time during the study). In addition, *flashcards* were produced for children to conduct timed practice sprints during the intervention period (see *Procedure*). Digital timers were used to time practice sprints and data collection sheets were used to record daily data. Recorded data consisted of the date, duration of session, number of correct and errors per minute timing, personal best scores and total timings conducted during the session. The children charted these data so that both the research team and each child could readily view their daily performance on each practice slice (writing numbers and single digit addition), allowing progress to be effectively monitored. Children were trained by the research team to record and plot their best scores of the day for each maths skill.

*Design*

The study used a mixed 2 X 2 design with one between group variable (group: fluency-building intervention vs. control) and one repeated measures variable (time of test: pre-test vs. post-test).

*Procedure*

Ethical approval was obtained from both Bangor University's Ethics Board and each school's Board of Governors, and informed consent was obtained from all children's parents or guardians.

Daily sessions took place in one of the school classrooms, directed by the researchers. The FBI group received the intervention in place of their timetabled lesson, whilst all the control children continued with their standard maths lesson in their usual classroom (specified by the school timetable).

## Pre-testing and pre-training

All children underwent both pre- and post-testing on the four selected essential skills. Initial pre-test performance was such that all FBI children began with digit writing and the simplest addition problems, which would provide confirmatory evidence that the children were performing below average and were likely to experience problems with more complex mathematical operations.

Before beginning the intervention, all FBI children were coached to enable them to not only record their data for each timing within the session, but also to graph their own progress (Maloney, 1993; Bower, 1985). We did this by teaching all the FBI children to chart. Furthermore, the researchers verified all charts to ensure the accurate recording and plotting of data. Teaching children to graph allowed them to observe their own learning improve as shown in the emergent learning pictures on the SCC (Lindsley, 1995; Claypool-Frey, 2009).

## Fluency building intervention

At the beginning of the session children would collect their work materials and proceed to their desks to work in pairs on their practice sprints. In a typical daily session, children would begin with a tool-skill warm-up task, writing digits 0–9. This prepared them for their daily timings and also enabled them to practice and increase their fluency at writing digits – an essential prerequisite skill for any written maths computation. They would then proceed to conduct three timed sprints from the maths worksheets, following which they would conduct the same number of timed sprints on their flashcards. Each child was allowed the flexibility to alternate between these two practice materials, as long as they completed their daily timings for each level of the maths problem they were working on. To prevent serial learning effects, the order of presentation for all practice sheets was randomised and the flashcards were shuffled before each sprint.

Practice sheets had maths problems for the level of difficulty at which the children were working and had sufficient space for children to write their answers. Answer keys were provided so that children could check their answers and record their data after each timed sprint. Initially, each timed sprint was typically 60s in duration but if the emerging learning picture on the SCC indicated, this timing could be shortened to 30s or 20s as an intervention for learning (Calkin, 2005; Johnston, 1970; White and Neely, 2004; Pennypacker et al., 2003; Lindsley, 1995). The decision to shorten timings would be made if the child's emerging learning picture on the SCC indicated that this would be a useful intervention (e.g. a child may significantly slow down towards the end of the 60s, which would indicate that they had a problem with endurance and suggest a shorter time period may work better for that child).

Flashcards had the maths problems (again for the level of difficulty at which they were working) written on one side of the card and the answer written on the reverse. The cards were consistent in their presentation, with the front side always displaying the numbers to add (e.g. 4 + 5 = __, or 5 + 4 = __), and the reverse side showing the answer to the math addition problem. Children worked in pairs with one child conducting the practice sprint and the other checking their answers. The child would shuffle the pack, then read the maths problem (silently), say the answer (aloud) and check their answer by turning the card to receive either corrective or positive feedback. Their partner counted and verified the number of correct responses and learning opportunities (LO) per timing, logged this information on the data sheet and then charted the best score of the day on the learning chart. Sessions took place at the same time each day.

Each time a child beat their personal best score they received a sticker, which was placed on the next space on their reward chart. At pre-determined points along this chart they could select an appropriate academic reward, such as a pencil, eraser or notebook. There were 56 points on the reward chart with gifts awarded at spaces 4, 13, 25, 39 and 56.

The FBI children received the intervention over a consecutive five-week period with each session lasting approximately 20 minutes. At the end of the intervention phase, the pre-test was re-administered as a post-test to all children.

### *Data analysis approach*

In addition to carrying out Analysis of Variance group-based statistical analyses of the results with associated effect sizes, we explored two indices that enable consideration of outcomes at an individual level. To evaluate change at the individual level, we adopted an index that has been successfully used in the medical literature and more recently has been used in special education. The Reliable Change Index (RCI) originated from psychotherapy outcome research (Jacobson and Truax, 1991), and recently it has been used to evaluate the clinical significance of outcomes in autism educational interventions (Remington et al., 2007; Eldevik et al., 2010). The RCI index identifies by how much an individual score needs to change to be significant at .05 level and takes into account typical variation in the scores in the population and stability of the measure over time. Improvement of performance at or above this index can be regarded as an educationally significant gain.

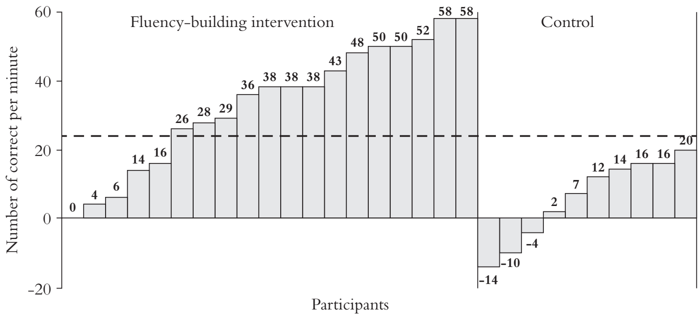
To ensure that this test was conservative the RCI was calculated using the means and standard deviations of the entire groups' scores at pre-test to calculate the SE. Multiplying the SE by 1.96 provides a measure of magnitude of change required to be reliable at the $p < .05$ level (Evans et al., 1998; Jacobson and Truax, 1991; Zahra and Hedge, 2010). For calculation purposes, stability of the test scores were estimated by calculating the correlation for these scores in the control group between pre- and post-tests, as this would provide a more accurate measure of stability as the control group had not received the intervention.

Using individual level outcomes such as those generated via the RCI, an effect size more commonly used in medical interventions (Number

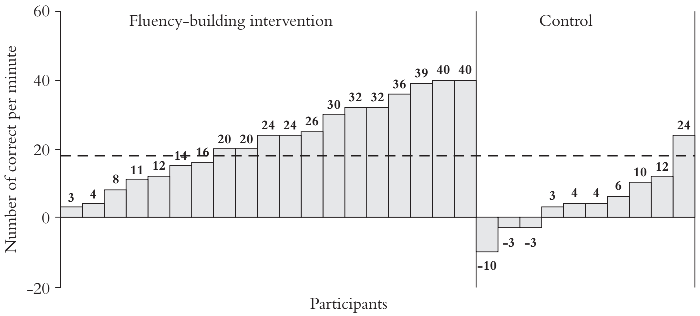
**Table 2**. **Mean numeracy skill scores at pre- and post-test for intervention and control groups and results of ANCOVA analysis. Effect size d was calculated comparing the change scores of the two groups for each skill using the pooled pre-test standard deviation.**

| | *Fluency-building intervention (FBI)* | | *Control group (C)* | | *ANCOVA* | | |
|---|---|---|---|---|---|---|---|
| | *Pre-test* | *Post-test* | *Pre-test* | *Post-test* | | | |
| | *M (SD)* | *M (SD)* | *M (SD)* | *M (SD)* | *F (1, 26)* | *p* | *d* |
| Writing digits | 72.37 | 105.63 | 72.30 | 78.20 | 22.87 | < .001 | 1.67 |
| | (20.83) | (17.81) | (7.78) | (16.42) | | | |
| Addition < 10 | 26.37 | 49.05 | 29.80 | 34.50 | 19.38 | < .001 | 1.60 |
| | (9.19) | (9.12) | (9.25) | (8.19) | | | |
| Addition >10 < 20 | 16.68 | 23.16 | 19.80 | 26.60 | 0.20 | .662 | -0.05 |
| | (7.78) | (9.28) | (9.54) | (8.04) | | | |
| Subtraction <10 | 19.47 | 35.89 | 24.50 | 29.10 | 9.80 | .004 | 1.25 |
| | (7.25) | (12.95) | (9.14) | (12.49) | | | |

**Figure 1. Charts comparing the individual performance of participants from both the FBI and control groups on the four different maths skills. Scores above zero are gains in performance from pre- to post-test, scores at or below zero are maintenance or losses in performance respectively. Scores above the dotted line indicate that the improvement is reliable at the individual level as measured by the Reliable Change Index (RCI).**

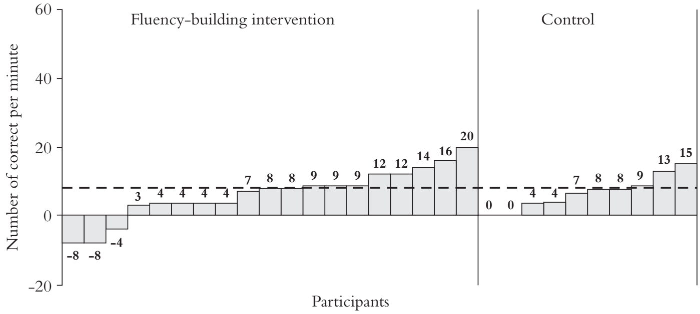



1 (a) Writing digits. RCI achieved by 14; FBI = 14 (74%), C = 0 (0%)

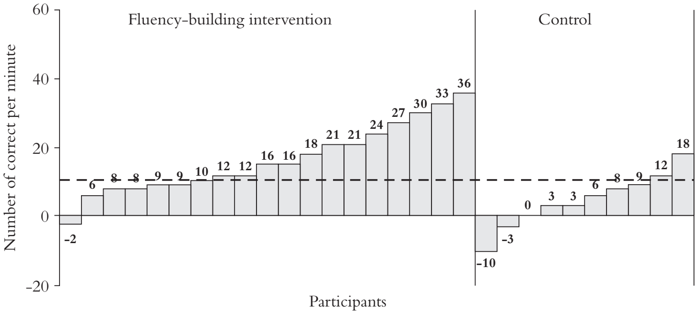



1 (b) Addition ≤ 10. RCI achieved by 13; FBI = 12 (63%), C = 1 (10%).

Needed to Treat, NNT) can be used to clearly communicate success rates of interventions in a clear manner. The NNT represents the number of children that would require to take part (be treated) in an intervention to have one more success or one less failure than would have been the outcome




1 (c) Addition > 10 ≤ 20. RCI achieved by 11; FBI = 8 (42%), C = 3 (30%)




1 (d) Subtraction ≤ 10. RCI achieved by 14; FBI = 12 (63%), C = 2 (20%)

if all children had not received the intervention or received an alternative intervention (Kraemer et al., 2003).

## *Results*

Mean scores on each numeracy skill pre- and post-test for the intervention and control groups are shown in Table 2. ANCOVAs comparing the groups' post-test scores and controlling for pre-test performance were conducted. The results indicate that for the first two skills that were practised by the FBI group (writing digits and addition <10) there was a significant difference at post-test compared to the control group. For the third skill (addition ≥10 ≤19; which was not practised by either group) there was no significant difference at post-test. However, for the fourth skill (subtraction <10), which again had not been practised by either group, the FBI group showed a significantly better performance in comparison to the control group at post-test. All three of the skills that showed a significant difference between the FBI and control groups had associated large effect sizes.

As the pre-test for writing digits had large variation for the FBI group, we ran the analysis again after removal of outliers (n = 5) – outliers were defined as any score above the highest score or below the lowest score for the control group at pre-test. No effect on the pattern of results was found – the group effect was still statistically significant.

Figure 1 highlights the results from the RCI analysis on the individual children's data. Every child in the intervention group either maintained or showed improvement at post-test for writing digits and addition <10. Additionally, for subtraction (not practised) all but one child in the FBI group improved at post-test and twelve children exceeded the criteria to achieve reliable change.

Figure 1 also shows the percentages of children who achieved reliable change from the intervention and control groups for each of the maths skills from the beginning of the study until post-test. It can be seen that for the two maths skills that were practised by the FBI children the range of children who achieved reliable change criteria for the significant skills was between 63 per cent and 74 per cent, whereas for the control children it was between 0 per cent and 20 per cent.

The NNT for the different skills were: (1) writing digits, NNT = 1.36, 95% CI [1.1–1.9], (2) addition <10, NNT = 1.88, 95% CI [1.2–4.1], (3) addition >10<20, NNT = 8.26, 95% CI [-4.8–15.2], and (4) subtraction, NNT = 2.31, 95% CI [1.3–9.8]. This shows a positive outcome for the NNT (i.e. because the numbers are low) for all but addition >10<20. These low NNT numbers represent the number of children that would require to take part (be treated/educated) in an intervention to have one more success than would have been the outcome if all children had not received the intervention (Kraemer et al., 2003). In simple terms, for approximately every two children receiving the intervention one child achieved individual change at a significant level than would have been expected if the children had been in the control group.

## *Discussion*

The aims of this study were: (a) to evaluate the effectiveness of a brief intervention using fluency-building practice sprints to build mastery of essential maths facts with children whose performance on numeracy problems was falling behind their peers, and (b) to ascertain whether this mastery would impact their ability to solve more complex untrained numeracy problems that relied on the acquisition of fluent performance repertoires in prerequisite skills.

The results from this brief intervention provide evidence of positive results in relation to both of these aims. The intervention group performed significantly better at post-test on basic numeracy tasks that they had practised (writing digits and single-digit addition). In contrast, no difference was found between the intervention and control group's performances at post-test on one of the maths task that had not been practised (double-digit addition). More importantly, although neither of the groups had practised basic subtraction problems the intervention group still performed significantly better at post-test than the control group. These findings concur with previous research (McDowell and Keenan, 2001; e.g. Chiesa and Robertson, 2000; Kubina and Yurich, 2012) that showed how brief fluency-building practice could impact on target composite skill performance, even when the target skill was never practised and only components of the target skill were.

We can postulate as to why some transfer to non-practised skills might occur. In mathematical operations, there is an inverse relationship between addition and subtraction (Stein et al., 2005). Therefore, it could be that increasing children's performance to mastery on basic addition facts also increased their performance on related subtraction problems. These concepts are also discussed within the cognitive literature, in that an increase in procedural fluency may have facilitated improved access to the addition-subtraction inverse concept (Rittle-Johnson and Siegler, 1998; Cowan et al., 2011; Briars and Siegler, 1984; Greeno et al., 1984; Gelman and Meck, 1983).

Additionally, if we consider the results at a more individual level, the data show that the majority of children in the intervention group met or exceeded the criteria required to achieve an educationally significant change (as assessed using the RCI). These findings, along with the low NNT score, would support the overall effectiveness of this brief fluency-building intervention. Furthermore, the findings are also consistent with the effectiveness of implementing more frequent measurements of each individual's learning to ensure adequate progress as would be used in interventions such as RtI, CBM or PT (Slavin and Lake, 2008).

As the intervention took place in an applied setting there were unavoidable limitations. For example, there was no control over the content that was taught to the children in the control group while the FBI children were being taught. Future studies should document or standardise the teaching that was used for the control children at the time of the intervention to better understand what was 'education as usual'.

Additionally, this brief intervention took place over just five weeks. Because of this relatively short duration, the children only received practice opportunities on lower level essential maths skills. It would be interesting for researchers in future to undertake a longer period of work on fluency-building, including a broader scope of essential skills to ascertain how much maths skills could be further improved. We used an education-as-usual control condition. However, we did not control for the personalised attention those children in the FBI group received, or for the potential influence of the Hawthorne Effect (Paradis and Sutkin, 2017; Verstappen et al., 2004). Future controlled trials should incorporate an attention control condition. In addition, it would be desirable to use additional standardised maths tests that would give more reliable results from which to interpret the effects of the intervention.

Future research should also be conducted to more systematically investigate the effects that building-component tasks to an appropriate fluency aim has on composite (untrained) task performance (as demonstrated in the present study when the children performed significantly better on the untrained subtraction task). There is a growing body of research indicating that working on component skills fluency has direct benefits for more complex tasks made up from those components (Johnson and Street, 2004; McDowell and Keenan, 2001; Kubina, 2002; Kubina and Morrison, 2000; Kubina, 2005). Conceptually, this is an interesting area for future research and suggests that variation in performance across individuals may be better accounted for by what Binder refers to as cumulative dysfluency (Binder, 1993, 1996). From a PT perspective, it would be fruitless to attempt to teach at the composite skills level if the prerequisite component skills were not first mastered. Intuitively, we may desire to aim our teaching directly at the skill with which a child is struggling. However, component skill fluency would suggest a possible alternative explanation for some aspects of academic failure – that the component skills necessary to do the more complex task are weak. If this is the case, intervention should be aimed at the component skill level, rather than at the more complex skill with which the child is actually exhibiting problems.

Although this was a brief intervention, part of its strength is that it is economical in its implementation as well as being educationally beneficial. It would be relatively easy to train teachers or classroom assistants in these methods and have them incorporate such procedures into their typical classroom activities without a large cost both in terms of teacher time and other resources (Roberts and Hampton, 2008; Chiesa and Robertson, 2000). This simple methodology has the potential to impact essential skills performance significantly in any educational setting. However, it is important to note that research has shown that it is not sufficient to simply train teachers in these methods: they must also receive further support and coaching to create sustainable change within organisations (Roberts and Hampton, 2008; Johnson and Street, 2004; Georgiades and Phillimore, 1975).

Our data add to the research that supports the notion that measuring learning in a classroom setting need not be cumbersome and time consuming, especially if children are directly involved in tracking and taking some of the responsibility for their own learning. This can be achieved simply by teaching children how to time, record and chart their own learning from the outset (Lindsley, 1995). Other researchers have commented that this aspect of the PT approach also seems to enhance children's confidence and 'ownership' of their learning (Lindsley, 1995; Maloney, 1993; Bower, 1985). Anecdotally, we found a similar effect.

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