Precision Teaching and Fluency Training: making maths easier for pupils and teachers

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SUMMARY  A 12-week programme was designed for five children in a primary class (9–10 years of age) who were failing to keep pace with their peers in the maths curriculum. The programme drew on principles of precision teaching and emphasised fluency training in the component skills required for the performance of a composite maths skill. The class teacher identified a target composite skill, and the five children’s scores were compared before and after the programme, and compared with the rest of the class. On post-programme measures, the precision teaching children out-performed all but one of their peers on the target skill. This paper adds to a growing database demonstrating the importance of fluency training and frequent monitoring of children’s progress (fundamentals of precision teaching). It also shows that expensive and time-consuming additional resources are not required to successfully implement such programmes.

Introduction

Precision teaching is recommended by a number of British educational psychologists writing in both the mainstream and special educational needs literature (for example, Muncey & Williams, 1981; Raybould & Solity, 1982, 1988a, 1988b; Solity, 1991; Kessissoglou & Farrell, 1995). As early as 1981, Muncey and Williams introduced precision teaching ‘in the hope of provoking further interest in it’ (p. 34). Their article was followed, in 1982, by an endorsement from Raybould and Solity who discussed precision teaching techniques in greater detail and reported on their use within one English education authority. Writing in 1995, however, Kessissoglou and Farrell noted that while American journals have continued to consider the validity of precision teaching, relatively little has appeared in the recent British literature concerning its viability and/or effectiveness. They commented that ‘there has been a recent dearth of British literature on the subject’ (p. 60).

It is true that the American literature continues to expand upon both the theoretical and applied aspects of precision teaching (for example, Howell & Lorson-Howell, 1990; Johnson & Layng, 1992, 1996; Lindsley, 1992, 1996; Miller
& Heward, 1992; Binder, 1993, 1996; Potts et al., 1993; Cancio & Maloney, 1994). If precision teaching is an aid to student learning, as its proponents claim, why then has it not made a greater impact in the UK’s educational psychology community and, more generally, in the UK’s teaching community? Some of the British papers may contain answers to these questions. For example, Raybould and Solity (1988a) noted in their introduction that teachers were still haunted by doubts and questions about precision teaching. In the same paper, they acknowledged that, in the course of training, “professionals frequently express queries or misgivings about different aspects of precision teaching and raise practical problems” (p. 32). Two articles by these authors (Raybould & Solity, 1988a,b) address and respond to a number of issues that recur in their involvement with professional training. These issues include: is precision teaching not incompatible with discovery learning? why the need to be so precise? does the emphasis on fluency not teach children to learn things parrot fashion? these probes are far too mechanical; I just do not teach like that; how do I organise precision teaching in my classroom? what is the best way to start?

More recently, Solity (1991) considered the part played by books and articles published in the late 1980s that present behavioural approaches as being “based on some questionable assumptions and [having] proved difficult to implement satisfactorily in many mainstream settings” (pp. 151–152; the texts Solity cites are Ainscow & Tweddle, 1988; Dessent, 1988; Whitaker, 1988). Negative appraisals of behavioural approaches, whether they refer to precision teaching or to other behavioural methods such as task analysis or direct instruction, may well have the effect of dissuading teachers from pursuing the development and implementation of these approaches in their own classrooms.

Tentatively, then, we can suggest at least two reasons for the dearth of British literature on precision teaching. First, it may be that classroom teachers are persuaded by parts of the educational literature that precision teaching is founded on a somewhat dubious philosophy of the learning person. In relation to the philosophical side of their work, behaviourists themselves are painfully aware of a long history of misrepresentation both within and without the psychological literature, and have even written texts on ‘the great power of steady misrepresentation’ (see Todd & Morris, 1983, 1992; Todd, 1987). Gradually, however, as empirical demonstrations of effectiveness expand, busy professionals may come to see that the practical consequences of behavioural approaches to learning in the classroom outweigh any philosophical misgivings.

Second, it may be that some classroom teachers consider the precision, quantification, and daily monitoring required by precision teaching programmes to be too demanding of their time in and out of the classroom; a position that evokes considerable sympathy. Classroom teaching has always been a highly demanding job and, since the phasing in of the national curriculum in 1989, teachers and administrators have come under more and more pressure to respond to national requirements for teaching, testing, and school evaluation. Seen from this perspective, it is understandable that busy teachers may consider the training required to become competent with the methods, in addition to the time they perceive is required to
implement precision teaching programmes, just one stress too many in their already busy lives. How can an educational psychologist who is interested in training teachers to use precision teaching circumvent either or both of these positions?

Expanding the Database

The way forward, we suggest, is to develop and expand upon the database of empirical demonstrations of the effects of precision teaching programmes, and to emphasise the value of fluency training and frequent monitoring for both pupils and teachers. If an individual teacher is dissuaded from developing precision teaching programmes in the classroom because of what are regarded as questionable assumptions underpinning them, words alone may not be enough to persuade such a teacher that this approach can be beneficial to pupils. Alternatively, if a teacher’s avoidance of precision teaching is grounded in the belief that the time taken to train and become competent in its methodology outweighs the potential benefits, such a teacher also needs to see directly that precision teaching programmes not only lead to effective learning for pupils, but are also an efficient use of his/her time.

This paper describes a precision teaching programme for numeracy with several characteristics of interest to classroom teachers:

- The programme was concise, focused on only one target skill: division of two-digit numbers by one digit, divisors up to and including five, and with remainders
- The programme was delivered to a small group of children who had fallen so far behind their peers that they were in danger of requiring costly remedial tuition
- The programme occurred during class periods normally devoted to the subject (i.e. the programme required no extra class or tuition time)
- The programme’s duration was brief, completed within 12 weeks
- Class contact time between researchers and children was a mere 30 minutes each week
- The precision teaching group out-performed all but one of their peers on a post-programme test of the target skill.

The contribution we hope to make in this paper is to provide an example of the effectiveness of daily monitoring and fluency building (fundamentals of precision teaching) that incurred minimal disruption to ongoing work in a mainstream classroom. For teachers thinking of adopting precision teaching methodology (notably fluency building) but concerned about time constraints, this report demonstrates that such programmes need not be all-encompassing, but can be tailored to suit the requirements of a specific classroom and a specific subject as they arise throughout the academic year.

Elements of Precision Teaching

A large number of articles outlining the principles and practices of precision teaching are now accessible (see, for example, Raybould & Solity, 1982; Howell & Lorson-Howell, 1990; Lindsley, 1990; West et al., 1990; Johnson & Layng, 1992; Miller &
Heward, 1992; Binder, 1996). Rather than providing a lengthy background section, the main elements of precision teaching used in the programme will be described. These are:

- Component/composite analysis
- Fluency training
- Time probes and the standard celeration chart
- Tailoring practice materials to the progress of individual children.

Before describing these elements, it is important to note that precision teaching is not itself a method of teaching. Rather, it is a general approach to determining whether or not an instructional method is achieving its aims. Precision teaching methodology allows teachers to measure instructional success and to tailor instruction to the individual requirements of pupils.

Component/Composite Analysis

Virtually every task we undertake requires the performance of several different behaviours at once. Thus, any task can be described as a composite and broken down into its prerequisite series of components. For example, if we want to hammer a nail into a piece of wood (a composite task), we must be able to: identify hammer, nail, and wood; grasp hammer securely with the dominant hand; grasp nail between thumb and forefinger; hold nail securely at the required angle even during hammer blows; and strike the head of the nail accurately and repeatedly with the appropriate part of the hammer. In an effort to strengthen a composite skill through fluency training, an analysis of its prerequisites (its components) is a crucial first step.

Fluency Training

In addition to the more typical measurement of accuracy, speed is considered to be important in the classroom, as in everyday life, because it provides a measure of expertise. Expert performance of any skill, whether it be carpentry, piano playing, reading text or solving maths equations, involves speedy as well as accurate performance (see Bloom (1986) for a discussion of speed as a criterion of expertise). We consider our carpenter expert because he/she puts our shelves up accurately in a fraction of the time it takes the amateur DIY enthusiast. Similarly, when scoring standardised IQ tests, the person who accurately completes the largest number of items in the time allowed achieves the highest score. In relation to numeracy skills, Miller and Heward (1992) point out: ‘All students who perform at the same level of accuracy are not equally skilled. While two students might each complete the same page of math problems with 100% accuracy, the one who finishes in 2 minutes is more accomplished than the one who needed 5 minutes to answer the same problems’ (p. 98). Fluency training is a method that fosters development of the fast and accurate rates on component skills that can greatly enhance the performance of composite skills and, indeed, can enhance the learning of new skills. It is axiomatic that if one child performs at a slow rate on one or more of the basic math skills (e.g.
number recognition, number writing, basic addition, and so on), their rate of learning a new and more advanced skill will be hampered in comparison with a child whose component skills are more fluent.

**Time Probes and the Standard Celeration Chart**

As they are used in a precision teaching programme, time probes provide an efficient means of measuring a student’s fluency in a rate-per-minute count on a given skill. Time probes can be as brief as 5 or 10 seconds or as long as 3 or 5 minutes depending on both the child and the skill being measured. For example, a young child in the early stages of number learning may not have the stamina to persist for a whole minute or more in repeating a number sequence and, for such a child, a 10 or 15 second probe may be appropriate. The rate of response on the time probe is then multiplied to give a rate-per-minute count for entering on a standard celeration chart (SSC). Alternatively, where a child is working on a more advanced skill (with more components), 3-minute probes may be more appropriate for deriving a rate-per-minute count, perhaps in circumstances where a composite cannot be completed in 1 minute. For example, we recently designed a programme for a teenager struggling with the standard-grade maths curriculum. Having mastered the components required to work out the area of a right-angled triangle, the composite skill was measured in 3-minute probes to give a representative rate-per-minute count (in the early stages, the student would have scored poorly on a 1-minute probe, which was not a good indicator of the student’s skills). Whatever length of time probe is used, the number of responses is always either divided or multiplied to give a rate-per-minute count for the SSC.

The SCC provides a ‘picture’ of learning, representing either acceleration or deceleration of correct and incorrect responses (for examples, see Raybould & Solity, 1982; White, 1986; Linslsey, 1990; West et al., 1990). A flat line on the SCC indicates a rate of response that is not improving and alerts the instructor that some aspect of their teaching, methods or materials perhaps, is having no impact on a child’s performance. An upward slope indicates an increase in performance rate, while a downward slope indicates a decrease in rate. The ideal learning picture is an upward slope of correct responses and a downward slope of incorrect responses, both of which can be easily plotted on the chart. Instructional decisions are guided by the learning picture that determines the design of practice materials and progression for each student.

**Individualising Practice Materials**

Although several children (or even a whole class) can be following a precision teaching/fluency programme aimed at a particular goal or composite task, ideally such a programme would be implemented in an individualised manner. The fundamental point of fluency training is to ensure that children master prerequisite skills before attempting to progress to more complex or more demanding skills. It goes without saying that there will be variability between children in the length of time
and/or amount of practice they take to reach mastery. Child A may well need more coaching and practice on multiplying by three, while child B storms through multiplication but struggles when trying to complete double-digit subtraction. Response rates per task, recorded on a SCC for each individual child, quickly reveal areas of strength and weakness, and allow instructors to adapt instructional materials for each child accordingly. Together, these four elements, fundamentals of precision teaching, formed the basis of a brief and highly effective numeracy programme in a primary classroom.

Outline of the Programme

In a class of 25 students, 9- and 10-year-olds (primary five), the class teacher and learning support teacher both identified the same five children (three boys, two girls) as candidates to participate. Although achieving standards comparable with their peers in other aspects of the curriculum, these children were simply unable to keep pace with their peers in the domain of maths.

Pre- and post-programme measures were taken for the whole class on a composite skill of the class teacher’s choice: division of two-digit numbers by one digit, up to and including five, and with remainders (e.g. 75 ÷ 3, 24 ÷ 4, 40 ÷ 5). Pre- and post-programme measures were collected using 1-minute time probes. The precision teaching group’s scores (n = 5) could then be compared against the control group’s (n = 20) both before and after the programme to give a measure of the impact of the programme.

The class teacher taught the composite to the whole class in the week prior to the programme’s start by drawing attention to multiplication tables hanging on the walls around the classroom. She explained that division was a matter of finding a missing multiplier, i.e. 40 ÷ 5 = ? is the same as 5 × ? = 40. The children were asked to look at the five-times table and find 40 after the equals sign. They were then asked to respond to the question ‘what do you have to multiply five by in order to get 40?’ The teacher modelled the process several times with different examples, then called on individual children to do the same. She then provided example sheets for the children to work independently at their desks. The whole class was taught the composite skill in this way and all children had the same number of opportunities to practice the skill.

To familiarise the class with time probes prior to measuring the composite skill, they first completed a sheet of mixed addition and multiplication sums. Subsequently, the whole class completed the composite skill time probe, a sheet of 55 dividing sums similar to those used by the class teacher during normal maths periods.

Throughout the programme, materials for the precision teaching group (PT group) were designed on the basis of component/composite analysis; by tracking back through a series of prerequisite skills, using time probes to check for dysfluency, and preparing practice sheets and new time probes to increase fluency. A SCC and digital timer was given to each of the PT group children.
Procedure

For the first session, the PT group was removed from the classroom and taught how to plot scores and interpret learning pictures on the SCC. Fluency training was explained and demonstrated in this session, and the group learned to use the digital timers. Practice sheets and time probes for the first component skill were distributed for the children to work on during the following week.

The class teacher allocated time for the PT group to carry out their work. This was always while she was teaching maths to the rest of the class so that, throughout the programme, the PT group and the rest of the class spent the same amount of time engaged on maths problems. The PT children sat together as a group during the maths period, a little way apart from the rest of the class. Each PT child had a personal folder containing practice sheets, time probes, and charts. Folders also contained answer sheets for the time probes and a checklist so that each child could complete their tasks independent of teacher instruction. Each checklist contained instructions to: complete a practice sheet; have the practice sheet marked by a peer; complete the time probe in 1 minute; mark the time probe using the answer sheet provided, and enter correct and error scores on the SCC. Throughout the programme, PT children worked from these folders without any assistance from their class teacher. Having been taught how to enter scores on the chart in the first session (and with the exception of the pre- and post-programme composite measures), scores were recorded by the PT children themselves.

Multiplication tables were not removed from the classroom walls at any time during the programme. PT children were advised that they could consult these tables during the completion of practice sheets but that, during time probes, they should turn their backs to the tables and not consult them since the goal of time probes was to complete as many problems as possible in the time allocated.

The second author returned to the classroom once each week for 12 weeks, taking with her a variety of instructional materials and time probes. Approximately 30 minutes was spent with the PT children, reviewing each child's rate of progress and making decisions about the next instructional stage on the basis of the learning pictures. These sessions also occurred during maths periods while the class teacher worked with the rest of the class. If a child's rate of response had steadily increased and reached a satisfactory level (between 40 and 50 responses per minute), practice sheets and time probes for the next skill in the hierarchy were provided. If the rate of response was not improving, other instructional materials were distributed. For example, one child's chart showed no improvement in rate of response for multiplication by three. Rates varied between 15 correct on day 1, and nine correct on day 5. The skill was further broken down and, for the next week, this child was given practice sheets and time probes for multiplying by three but only using numbers up to and including five. When progress was satisfactory on this component, the child was moved on to multiplying by three using numbers between six and 10. Similarly, rates of response failed to increase consistently for three children on time probes for two different skills (multiplying by one and multiplying by two). Although these
Children could respond with reasonable speed when required to say correct responses aloud, their rates of response in the written mode were not improving. These children were given practice sheets and time probes to speed up number writing. In this way, the programme was individualised each week depending on the learning picture presented by a child's SCC.

**Component Tasks**

Since multiplication is the inverse of division, fluency in dividing one number by another depends, in large part, on mastering multiplication tables (the class teacher had already pointed out this relationship in teaching the target skill). The programme therefore began by providing practice and fluency building in multiplication tables, beginning with the one-times table. Since the target skill involved divisors up to and including five, practice and fluency building did not go beyond the five-times table. However, once this had been mastered, it was then important to again clarify the relationship between multiplication and division by providing opportunities to complete 'missing factor' problems, e.g. find the missing factor in $5 \times ? = 40$. At the appropriate point in the programme, the second author modelled several 'find the missing factor' problems on the board. She then reminded pupils that division is the inverse of multiplication and illustrated this by writing several inversions on the board, e.g. $5 \times ? = 40$ is the same as $40 \div 5 = ?$. Once this step was in place, children could then be moved on to traditional division problems.

Following the pre-test, the PT group received practice sheets and time probes in the following order (individual children's numbers in brackets where appropriate): one-times table (whole group); two-times table (whole group); number writing practice (pupils 1, 3, 5); peer practice (pupils 2, 4); three-times table (whole group); three-times table with multipliers up to and including 5 (pupils 1, 5); three-times table with multipliers greater than 5 (pupils 1, 5); four-times table (whole group); four-times table with multipliers greater than 5 (whole group); five-times table (whole group); find the missing factor, e.g. $5 \times ? = 40$ (whole group); division of two-digit numbers by one digit, up to and including five, no remainders (whole group); division of two-digit numbers by one digit, up to and including five, with remainders (whole group).

Table I presents a description of materials PT children were given and tasks they had to perform in relation to a selected list of component skills. On each component (with the exception of number-writing practice), pupils completed one practice sheet and one (1-minute) time probe per day. Every practice sheet contained 40 examples of the task (40 problems). In the case of multiplication tables, practice sheets contained at least four opportunities to perform each calculation in the table, i.e. the times-two practice sheet contained four opportunities to perform $2 \times 3$, four opportunities to perform $2 \times 5$, and so on. For multiplication up to/including five and greater than five, practice sheets contained eight opportunities to perform each calculation. For time probes, pupils were given two 40-problem sheets different from those used to practice. The time probes therefore allowed for up to 80 responses per minute.
Table I. Examples of materials given to PT children and tasks they had to perform

<table>
<thead>
<tr>
<th>Component skill</th>
<th>Materials and tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplication</td>
<td>Practice: one practice sheet per day, 40 multiplication problems (e.g. 2 \times 3 = ?)</td>
</tr>
<tr>
<td></td>
<td>Time probe (1 minute): one per day, two pages, 40 problems each page</td>
</tr>
<tr>
<td>Number writing</td>
<td>Practice: no practice sheet</td>
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<td></td>
<td>Time probe (1 minute): one per day. Pupils had a sheet of lined paper; on each line, they had to write number sequences 0–9 as fast as possible</td>
</tr>
<tr>
<td>Peer practice</td>
<td>Practice: working in pairs, pupils read a sum aloud and said the answer. The partner provided feedback in terms of either correct or error</td>
</tr>
<tr>
<td></td>
<td>Time probe (1 minute): one per day, written responses</td>
</tr>
<tr>
<td>Find the missing factor</td>
<td>Practice: one practice sheet per day, 40 problems (e.g. 5 \times ? = 25)</td>
</tr>
<tr>
<td></td>
<td>Time probe (1 minute): one per day, two pages, 40 problems each page</td>
</tr>
</tbody>
</table>

We noted previously that there was variability between children in the length of time and/or amount of practice they take to reach mastery on different tasks and that, while child A may need additional practice on multiplying by three, child B may quickly reach mastery on this task but require more practice on a different task. As expected, the PT children progressed through their materials at individual rates. That is to say, while one child required extra practice and fluency training in multiplication by five, another child quickly improved on that component but needed additional practice on finding the missing factor. All five children in the PT group had completed training on all components by the end of 12 weeks.

Results

Pre- and post-programme scores are presented in Table II along with means and standard deviations for each group. Pre-programme scores range across the class from 0 to 11 correct responses per minute, with the largest number of children (48%) correctly completing either two or three composite tasks. Only six children in the entire class (24%) completed more than three composites during the time probe, with seven children (28%) completing less than two composites. On the time probe in week 1, none of the five children in the PT group completed more than two composite problems correctly. Although their rate-per-minute scores appear little different from nine other children in class (see scores for pupils 6–14 in Table II), the class teacher and the learning support teacher nevertheless felt that it was these five children who were most in need of fluency building.

Mean scores for the PT group increased from 1 prior to the programme to 13.2 on post-programme measures, while control group means increase only modestly from 3.7 pre-programme to 4.2 post-programme. Unrelated t-tests show that, prior to the programme, there was no statistically significant difference between scores for PT and control groups (t = 1.962, two-tailed test; \( p > 0.05 \)). After the programme,
however, the same test showed a statistically significant difference between the two groups ($t = 5.49$, two-tailed test; $p < 0.001$).

The PT group scores after 12 weeks of fluency building show dramatic increases in fluency on the composite skill (see Table II and Figure 1). Rates range from 11 to 15 correct responses per minute, increases of 10-15 responses per minute over the children's pre-programme scores.

In contrast, the control group scores after 12 weeks of normal classroom maths activity range from 0 to 14 and show high levels of variability (see Table II and Figure 2). Seven pupils in this group (35%) had lower rates of correct responses at the end of 12 weeks than at the start (pupils 13, 15, 16, 18, 19, 23, 24). Rates were unchanged in 15% of cases (pupils 6, 17, 20), while for the 10 pupils (50%) whose rate did improve, the majority (eight) increased by only 1-3 responses per minute and only two increased their rate by as many as 5 and 6 responses, respectively. From a position of having been considered in need of remedial tuition at the start of the programme, the PT group out-performed almost the entire class (one exception, pupil 25) on the composite task.

### Table II. Rate per minute, composite task, weeks 1 and 12

<table>
<thead>
<tr>
<th>Pupil number</th>
<th>Week 1</th>
<th>Week 12</th>
<th>Pupil number</th>
<th>Week 1</th>
<th>Week 12</th>
</tr>
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<tbody>
<tr>
<td>1</td>
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<td>2</td>
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<tr>
<td>5</td>
<td>2</td>
<td>15</td>
<td>10</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Mean</td>
<td>1</td>
<td>13.2</td>
<td>11</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>SD</td>
<td>0.71</td>
<td>2.05</td>
<td>12</td>
<td>2</td>
<td>7</td>
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<tr>
<td>13</td>
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<td>25</td>
<td>11</td>
<td>14</td>
<td>Mean</td>
<td>3.7</td>
<td>4.2</td>
</tr>
<tr>
<td>SD</td>
<td>3.01</td>
<td>3.49</td>
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</table>

In contrast, the control group scores after 12 weeks of normal classroom maths activity range from 0 to 14 and show high levels of variability (see Table II and Figure 2). Seven pupils in this group (35%) had lower rates of correct responses at the end of 12 weeks than at the start (pupils 13, 15, 16, 18, 19, 23, 24). Rates were unchanged in 15% of cases (pupils 6, 17, 20), while for the 10 pupils (50%) whose rate did improve, the majority (eight) increased by only 1-3 responses per minute and only two increased their rate by as many as 5 and 6 responses, respectively. From a position of having been considered in need of remedial tuition at the start of the programme, the PT group out-performed almost the entire class (one exception, pupil 25) on the composite task.
Discussion

Our results support a general contention that fluency training is an effective skill-building method and that daily practice, time probing and individual tailoring of materials can bring about rapid improvement for pupils whose previous performance gave cause for concern. They also support a specific contention that 'some fluency training is better than none'. The high levels of variability in performance among the control group and their generally poor performance in comparison with the PT group suggest that the five children identified as being in need of fluency building were not the only children in the classroom who might have benefited. Any expectation that, for example, general maturational processes or the practice of a range of mathematical skills occurring during the 12 weeks would 'naturally' enhance the performance of the control group is contradicted by the results in this paper. The number of correct responses per minute increased for only 50% of the control group, and those increases were modest in comparison with gains made by the PT group. Thirty-five percent of the control group had lower rates after 12 weeks, and rates for three pupils showed no change (one of those pupils still could not complete the composite task correctly in 1 minute at the end of 12 weeks).

While it might be objected that the PT group’s superior performance on the composite task merely reflects their greater familiarity with time probes and with the composite task itself, this objection fails to take note of the central points we are trying to convey concerning fluency, mastery, and progress through the maths curriculum. Bear in mind that the PT children did not spend any more time engaged in maths than the other children in the class. They worked independently (without
the teacher's instruction or assistance) on practice sheets and time probes every day for the same length of time as the control group children were being taught maths by their class teacher. The crucial difference is in what they did during maths periods: worked on components; practiced for fluency (speed plus accuracy); and progressed at individual rates through the curriculum. Bear in mind also that, in achieving fluency on the target skill, the PT group mastered multiplication tables one to five, whereas the control group's performance suggests that many of them may be dysfluent in some or all component skills that make up the composite. Multiplication facts and competence in dividing are prerequisites for any number of higher-level maths operations (solving equations, fraction and percentage work, geometry calculations, and so on). The control group's scores suggest that, without the benefit of fluency in prerequisite skills, many of these children will experience difficulty in learning and becoming competent with these higher-level tasks, and may go on to experience difficulty later in the maths curriculum.

The benefits of such a programme to pupils struggling with their maths curriculum are obvious in the tables and figures presented in this paper. What we are unable to show in this study is the way in which the PT pupils' relationship to their maths generally changed as the programme progressed. Other authors (for example, Kessissoglu & Farrell, 1995) have observed that children enjoy the procedures involved in fluency building and charting their own performances. Likewise, the children in our study took to the procedures enthusiastically and frequently asked for more practice sheets and time probes. This was from a group of children who used to groan audibly at the mere mention of maths.
The benefits of such a programme to classroom teachers should also be fairly clear when time and materials are considered. Contact between the second author and the PT group amounted to 30 minutes per week. This time was used to distribute the following week's work and admire the progress evident on childrens' charts. Since the PT children completed their practice sheets and time probes during the normal class period for maths, no extra time had to be scheduled to give additional support to these children. Given that both authors are skilled (fluent) in the interpretation of standard celeration charts and in the preparation of practice materials and time probes, it was a relatively simple matter to prepare materials for all five children in approximately 45 minutes per week. Master copies of the materials can then be filed along with other already prepared materials and copied for later use with other children, thus reducing preparation time for the teacher in future.

There are a number of questions still to be answered about the effects of fluency training and their place in mainstream classrooms. For example, we would ideally want to know if the PT group's rates of response endured days or even weeks after the programme ended and how those rates of response affected the learning of new composite tasks. In the programme reported in this paper, we were unable to collect the necessary measures, but these are two of the questions being addressed by a programme currently underway. We also hope, in the future, to address the integration of programmes such as these for larger numbers of children in a class. The five PT children in this study clearly benefited from their experience, but the pre- and post-programme results also suggest a considerably larger number of children in the same class would have benefited from the programme.

The results presented provide an example to classroom teachers, school administrators, and educational psychologists that special assistance to struggling pupils need not be expensive and highly consuming of time and resources. In addition, classroom teachers may be better persuaded by these results to design and implement small-scale precision teaching/fluency programmes in the first instance before attempting to move on to whole-class programmes.

References