



Using retrieval practice improves pupil progress in times-table tests with Year 4 pupils – a randomised controlled trial

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PURPOSE OF THE RESEARCH

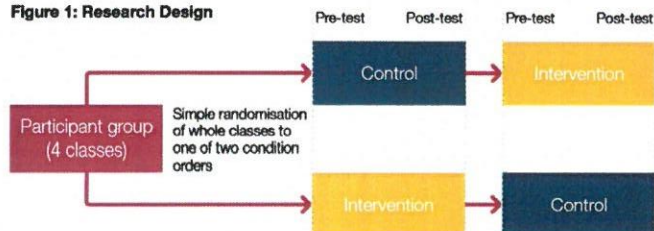
The use of testing in education has historically been an area of contention. Despite this, a growing body of research, from both neuroscience and cognitive psychology, into the use of testing as a learning event rather than as a means of measuring attainment and progress, has shown that simply attempting to retrieve knowledge, concepts or skills can lead to improvements in retention and subsequent retrieval (Bjork and Bjork, 2011; Roediger and Karpicke, 2006a, 2006b). The term 'testing effect', also known as retrieval practice (see Churches, Dommert and Devonshire, 2017), has become widely used in the cognitive learning literature to describe this phenomenon (Glover, 1989; Spitzer 1939). Much of the previous research into the testing effect and the use of retrieval practice has been examined in laboratory settings and has often been dissimilar to real educational tasks (Cranney et al., 2009). Recent studies, however, (McDermott et al., 2014; Karpicke and Blunt, 2011; Larsen, Butler and Roediger, 2009; Roediger and Karpicke 2006b; Leeming, 2002) have sought to demonstrate that previous findings could be transferred more specifically to educational settings. These studies have focused on the learning of more challenging concepts in older children or adults. The purpose of this study was to ascertain whether using retrieval practice (in the form of regular, low-stakes testing) would improve times-table recall in Year 4 children.

THE RESEARCH DESIGN

A within-participant design was used with a pre- and post-test. The independent variable 'testing effect on recall/retrieval' was operationally defined by creating two counterbalanced conditions:

- IV level 1 – Control: children received 20 minutes of times-tables practice every day
- IV level 2 – Intervention A: children received 15 minutes of times-table practice with a 5-minute test

Figure 1: Research Design



The children learned different times-tables for each block of assessment. The research was counterbalanced to reduce any potential carryover effects (see Churches and Dommert, 2016).

METHODS

Participants, sample size and randomisation

Four classes of 8- and 9-year-old children from two schools within the Pickwick Learning Teaching School Alliance took part in the study. The pupils were taught in mixed-ability classes randomly allocated to the order in which they experienced the counterbalanced conditions. The overall sample size when absences were accounted for came to 97 children.

Procedures

At the beginning of the learning period, the children completed a pre-test comprising of specific multiplication facts. The order in which the times-table facts were presented was randomised. In turn, this was counterbalanced across the classes so that two started on the 7 times-table and the remaining on the 8 times-table. This was the pre-test and the data was recorded for comparison with the post-test data. The times-tables sessions used a combination of best classroom practice strategies. This included oral chanting, making links between the multiplication facts and written practice. When experiencing the intervention, the pupils received the same pre- and post-test to ensure that the learning process was consistent. After the learning period, all pupils completed a randomised post-test on the times-table they had been learning.

Materials (and apparatus)

Pre- and post-test questions for each of the multiplication tables used were distributed to all teachers. Scripted PowerPoints containing the learning for the lesson, including the intermediary tests for the intervention groups and the class-based learning for the control, were also distributed to the staff. This approach was taken to reduce variation in teacher delivery and thus the effect of any extraneous variables associated with such variation.

LIMITATIONS

The trial was limited by its small sample size and therefore requires replication with greater numbers. Across schools and classes, some of the results may have been affected by the wide range of minor extraneous variables (e.g. timing of lessons, teacher style and the amount of time given to answer each question). The ceiling effect within the study meant that it was not possible to fully assess the effect of the intervention on the highest-attaining pupils at pre-test.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

This research suggests that using retrieval practice does improve pupil progress in times-table tests of Year 4 pupils. In practice, this implies that children who are given low-stakes tests throughout their learning of times-tables facts are more likely to make progress, and therefore this offers an alternative method to aid children's learning. Future studies may wish to replicate the design across schools in differing socioeconomic localities, alternative year groups and with larger sample sizes. Researchers may also wish to consider double counterbalancing (see Churches and Dommert, 2016) to further reduce potential carryover effects.

RESULTS

Gains scores were first calculated from pre- and post-test results in Figure 1. A one-tailed Wilcoxon signed-rank test indicated that the intervention had a significant ($p = .001$) positive effect ($r = 0.22$, $CI (95\%) = 0.08 - 0.35$) compared to the control condition. Due to a number of pupils attaining the highest score possible in the pre-test (meaning that the trial may have been limited by ceiling effects) the analysis was repeated with these scores removed (Figure 2). This second analysis indicated an increased positive significant effect ($r = 0.32$, $p = .001$, $CI (95\%) = 0.13 - 0.48$)!

Figure 2: Pre- and post-test scores for multiplication testing compared to the control condition (N=97)

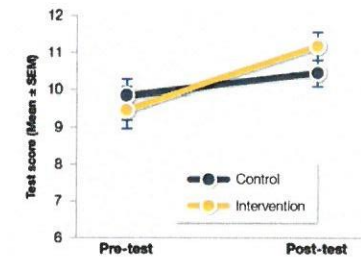
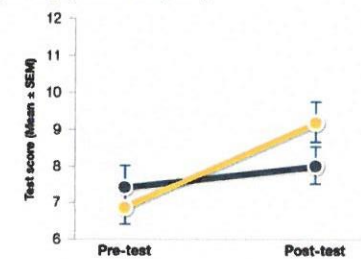


Figure 3: Pre- and post-test scores for multiplication testing compared to the control condition – ceiling effect pupils removed (n=50)



*Test identification and analysis were carried out using StatsWizard®.

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