Institute for Effective Education
Empowering educators with evidence

Research Schools Network

Increasing times tables fluency

Underwood West Academy

Problem: What challenges do your school(s) have that need to be addressed?

There is currently much debate about the best way to teach times tables, especially as the Government has announced that it intends to bring forward a timed, online tables test for children in Year 6 next year. It is advantageous for children to be able to recall multiplication facts fluently in order to reduce "cognitive load" (Sweller, 1988) when attempting larger calculations so that in a written calculation of, for instance, 234 x 46, six individual "times tables" products need to be found. Thus, finding the best balance of approaches to teaching times tables would benefit both teachers and pupils.

Many children find recall of times tables facts reasonably easy but many find it difficult to recall them in timed tests or in applying them to wider reasoning problems.

Innovation: How will the innovation help improve the problem you have identified and benefit teachers and learners?

Year 4 classes will carry out a different balance of conceptual and procedural times tables activities four times per week in the balances 1:3 / 2:2 / 3:1 / 0:4 and 4:0.

The research I carried out earlier this year suggests that a balance with a greater weight of conceptual activities will produce a more positive effect in helping children to improve fluency with multiplication facts.

Existing evidence: What evidence is there that this innovation will improve outcomes?

Research by Jo Boaler (2015), suggests that speed and memory activities are not the best way for children to become fluent in their understanding of multiplication facts and that it is more important to develop "number sense" rather than memory. Other research (Beilock, 2011) suggests that an approach which emphasises timed tests as the main way of approach to teaching tables facts can discourage children from learning in maths for life and lead to "maths

anxiety".

Last year, in association with North West Maths Hub 2, I evaluated the impact of using a completely conceptual approach – one in which children work on the connections and patterns in multiplication facts rather than memorizing them. Year 3 classes in 22 schools were asked to replace, over one term, "business as usual" in teaching times tables with games such as:

- Card games based around showing the tables facts as a variety of types of arrays – arrays of dots and other shapes – as simple tables facts, as products and as repeated addition.
- Pepperoni Pizza – in which children throw a dice to decide the number of pizzas then another to show how many pepperonis on each and then have to say the product e.g. 3 lots of 4 pepperonis equals 12 pepperonis.
- How close to 100 – in which children throw dice to decide how many squares to colour in an array on a 100 square until they are all coloured and one has coloured the most.

This "conceptual" approach contrasted with a "procedural" approach in which children are asked to practice the recall of tables facts in games such as board or grid games and further contrasted with an approach to "teaching" tables which consists of frequent timed tests.

The research showed an effect size of 0.3 for the treatment classes in a short timed times tables test against "business as usual" (Avis, 2017), suggesting that more investigation of the optimum balance of procedural and conceptual approaches would be helpful.

Research question or hypothesis: What effect will the intervention, implemented for how long, with which pupils, have on what outcomes?

Which balance of procedural and conceptual approaches to teaching times tables carried out four times per week over one term, is most effective in improving scores in a timed times tables test for pupils in Year 4?

Method: Include sample, design, measures, intervention, process evaluation, and analysis

Sample/ participants

Children from 16 schools in Year 4 classes, mainly from schools in Cheshire East, will participate. Year 4 was chosen as it is the first year group which is required to work on all of the times tables to 12.

The schools in the sample vary from one form entry rural and semi- rural primary schools to three form entry primaries in large towns. They also vary from schools with few children in receipt of Pupil Premium to schools with over 60% of the children in receipt of Pupil Premium. Consent will be gathered from Headteachers and Classroom Teachers and an information letter will be sent to the parents and carers of the children in all of the classes explaining the trial and that they can opt for their children's data to be excluded from the trial and that they can be excluded from the pupil questionnaire.

All data will be anonymised and it will not be possible to link individual data to schools.

Design and assignment to condition

Following a pre-test, classes will be matched in an alternative treatment design to five different conditions (ratio of conceptual to procedural approaches) using an Excel spreadsheet approach outlined in the EEF DIY Evaluation Guide so that there is a relative balance of pre test scores across all five conditions. This will be validated by ANOVA. Where there is more than one class in a school, they will be assigned to different ratios but not to ratios which are greatly different i.e. not 4:0 and 0:4.This process will be carried out by the Director of the Aspirer Teaching Alliance who will be unconnected with the research.

Children will not be identifiable by name but codes will be used to identify gender and receipt of Pupil Premium to allow sub group analysis of the results.

Measures

Before the trial, all of the classes will take a timed times tables test consisting of 25 tables questions from 12 tables fact sets which will be read out twice and children given eight seconds to write the product for each question.

The same test, with the same constraints will be administered at the end of the term.

This will be administered by a member of staff from the Aspirer Teaching School who has no knowledge of which condition the class has been assigned to.

Intervention

Following a pre-test of times tables recall, classes will be assigned to one of five condition groups. Each group will have a times tables teaching session four times a week for 15 minutes per session. In each group, a different ratio of procedural to conceptual tables teaching activities will be used. The sessions will be led by the class teacher.

	Procedural :	Conceptual
C1	1	3
C2	2	2
C3	3	1
C4	0	4
C5	4	0

The activities to be used will be contained in a booklet divided into procedural and conceptual activities and all teachers will have one training sessions on using the materials. None of the individual activities will be timed. The conceptual activities will be those used in the research carried out by Mark Avis in the summer 2017 term – card games based on the connections and patterns in the times tables as outlined earlier. The procedural activities will be games and other activities which require children to practise tables such as paired games, dice games and board games (not in the form of a timed test).

The groups which are working on a ratio of 4:0 and 0:4 will only be provided with the booklet of activities for one type of approach to avoid “contamination”.

All classes will be provided with all of the materials at the conclusion of the evaluation.

This will proceed over the summer 2018 term and there will be a post–test which will be identical to the pre-test. The results for each group will then be compared to the pre-test to determine how effective each condition is in improving tables recall fluency.

Process evaluation

A confidential teacher questionnaire will be given to gather teacher perspectives on the different approaches and teachers will be asked to keep a journal detailing which activity they did on each day and any comments that they may have on the process. Children will complete a short questionnaire to gather their thoughts about the process.

The project leads will carry out a fidelity visit to each school during the project to check that the

materials are being used in the way that is envisioned and in line with the training.

Data analysis

A mean pre-test score will be calculated and mean post-test scores will be calculated for each condition. Mean post-test scores will then be compared to the mean pre-test score to achieve a comparison in improvements between the conditions.

A sub group analysis will be carried out to determine if any approach was particularly effective / non effective for girls or boys and for children in receipt of pupil premium.

Conclusion: What will happen if your innovation improves outcomes, or not? What are the limitations of your evaluation?

Potential limitations

Small sample size limits validity.

Validity will be further limited if attrition is high. Attrition in the submission of data will be reduced by using Aspirer staff to conduct the tests and bring the results back to the project organisers.

Using a self-made test. Although this is a simple comparison of effect, the test will not be the same as the one to be used in the national tests so will lack alignment to national norms.

Implications

Positive – publish evaluation report and disseminate through Research School and maths hubs. Instigate debate through Research School and Teaching School Alliance about next steps for improving tables teaching. Disseminate materials at cost to whoever wants them.

Neutral / Negative - publish evaluation report and disseminate through Research School and maths hubs. Instigate debate through Research School and Teaching School Alliance about next steps for improving tables teaching.

References

Avis M (2017) Times Tables: Business as usual or a better balance? http://www.aspirerteachingalliance.co.uk/attachments/download.asp?file=51&type=pdf

Beilock S (2010). *Choke: What the secrets of the brain reveal about getting it right when you have to*. Simon and Schuster.

Boaler J (2015). Fluency without fear: Research evidence on the best ways to learn math facts. *Reflections*, *40*(2), 7-12.

Sweller J (1988). Cognitive load during problem solving: Effects on learning. *Cognitive science*, *12*(2), 257-285.

Institute for Effective Education
Berrick Saul Building, University of York, York YO10 5DD
t. 01904 328166 | f. 01904 328156 | info@the-iee.org.uk | www.the-iee.org.uk