

# Which method of approaching learning times tables, through procedural, conceptual or a mixed approach, improves learning for children in Years 3 and 4, when carried out four times a week over an eight week period?

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## Purpose of the Research

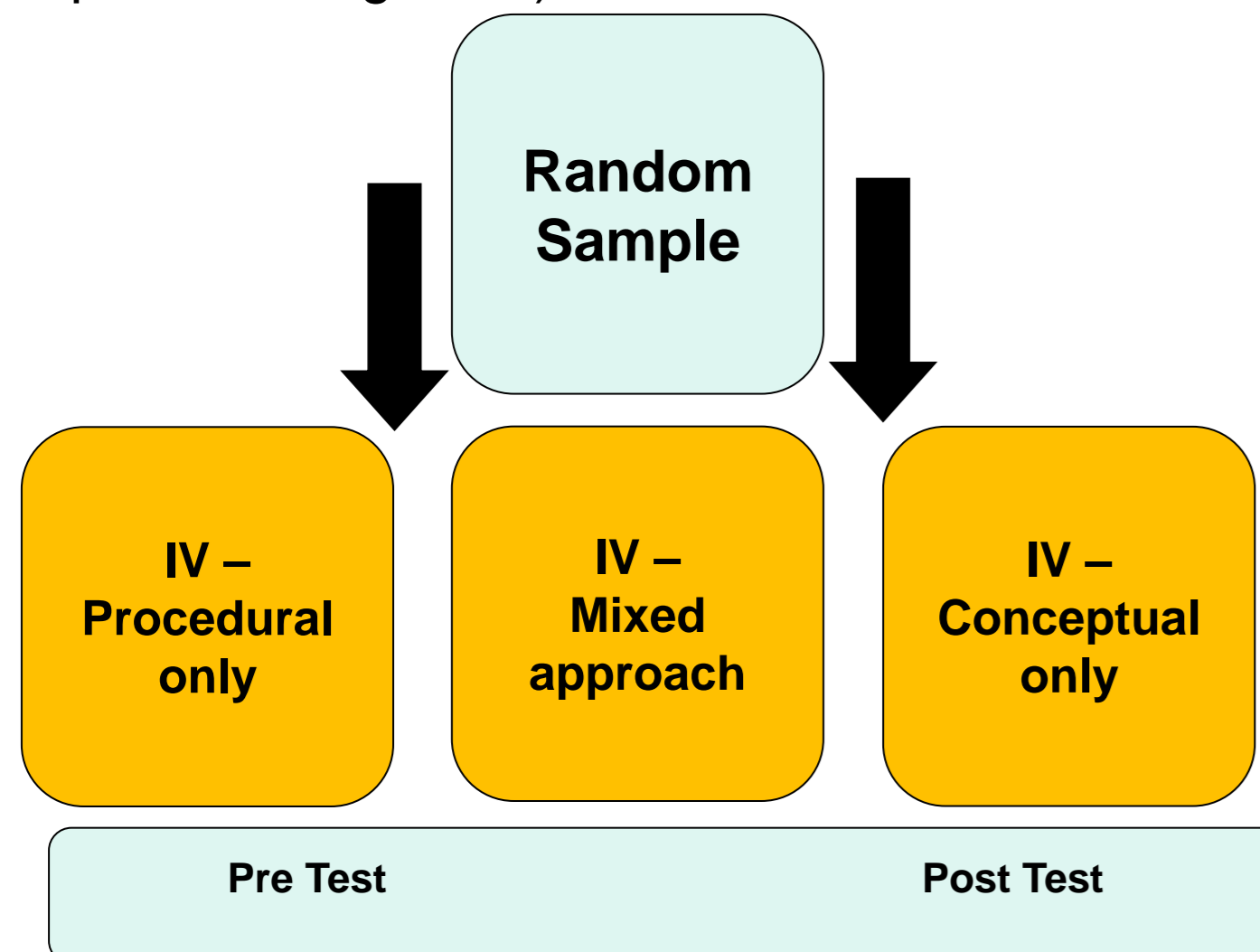
### Existing Research

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”. This trial builds on the work undertaken by Underwood West Academy: <https://the-ieee.org.uk/what-we-do/innovation-evaluation-grants/increasing-times-tables-fluency/>

## Research Design and Measures

The trial examines two different approaches to teaching times tables in Year 3 and Year 4. Both approaches use games. One set of games is ‘procedural’; the other set is ‘conceptual’. We examine three treatments:

- ‘Procedural only’: 4 sessions per week of the procedural approach (with no conceptual games).
- ‘Mixed approach’: 2 sessions per week of conceptual instruction; 2 of procedural.
- ‘Conceptual only’: 4 sessions per week of the conceptual approach (with no procedural games).



This trial had two outcome measures. The first was an *Procedural test* in which teachers read 60 times tables questions aloud; students had 3 seconds to write down an answer. This instrument focused primarily on times tables fluency. The second test presented students with 16 *written* problems. These questions focused on times tables but also required an element of conceptual understanding

## Methods

### Participants, Sample Size and Randomisation

Before describing the main quantitative conclusions, it’s worth emphasizing that this trial had two outcome measures. The first was an *Procedural test* in which teachers read 60 times tables questions aloud; students had 3 seconds to write down an answer. This instrument focused primarily on times tables fluency. The second test presented students with 16 *written* problems. These questions focused on times tables but also required an element of conceptual understanding. Before randomizing, we collected information on 6 covariates at the Year-class level:

**Baseline\_Procedural:** the pre-test focussed on procedural questions. The teacher reads out 60 multiplication questions. The score is the class average.

**Baseline\_written:** the pre-test focussed on conceptual questions. There are two versions. Year 3 students answer 7 questions. Year 4 students answer 16 questions. Again, scores are class averages.

**Class size:** number of students in the class

**EALp:** the percentage of students in the class who don’t speak English at home

**FSMp:** the percentage of students in the class are eligible for Free School Meals

**SENp:** the percentage of students in the class with special educational needs  
**A sample** of 19 primary schools, all located in Lincolnshire. The sample consisted of 36 classes: 14 Year 3 classes, 16 Year 4 classes, and 6 mixed classes in which there are both Year 3 and 4 students. The distinction between Year 3 and Year 4 is important for two reasons. First, outcome tests differed by Year Second, it is plausible that the treatment impacts are moderated by age. The evaluation focusses on the ‘year-class’ unit. Viewed from this perspective, the sample consists of 20 Year 3 classes, and 22 Year 4 classes. Some classes are mixed: i.e. contain both Year 3 and Year 4 students. We treat each mixed class as two separate units: a Year 3 ‘Year-class’ and a Year 4 ‘Year-class’.

**Attrition** was low, with only 2 classes out of 42 dropping out. Missing data was also kept to low levels. In the grade 3 sample, full data was collected for 336 out of 394 students who were randomized; in the grade 4 sample, full data was available for 387 students out of 440 students present at randomization.

## References

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## Results

The following conclusions should be fed into the broader evaluation.

The procedural games were moderately better than conceptual games in boosting scores on the *Procedural* test (focused on rapid recall). Students in Year 3 who were taught only with procedural games answered an average of 6 more questions correctly (out of 60).

Equally and oppositely, the conceptual games outperformed the procedural games on the *conceptual* test (focused more on problem solving with times tables). Students in Year 3 who were only taught the conceptual games answered 1.6 more questions correctly (out of 16). Effects were driven by Year 3 classes. We saw no evidence of differences among Year 4 classes.

The mixed approach was not statistically different from either the procedural-only or conceptual-only. It is tempting to advocate for this balanced approach, but across our analyses the mixed approach never had the highest average impact.

Year 3	Sample	Procedural Test (Confidence intervals in parenthesis)	Conceptual Test (Confidence intervals in parenthesis)
Conceptual vs Procedural	12 classes 218 pupils	-0.33 [-0.55, -0.09]	0.36 [0.06, 0.66]
Procedural vs Mixed	13 classes 246 pupils	0.20 [-0.05, 0.46]	-0.20 [-0.50, 0.11]
Conceptual vs Mixed	12 classes 208 pupils	-0.13 [-0.40, 0.14]	0.17 [-0.16, 0.49]
Year 4			
Conceptual vs Procedural	13 classes 241 pupils	0.06 [-0.19, 0.31]	-0.01 [-0.29, 0.28]
Procedural vs Mixed	13 classes 265 pupils	0.16 [-0.02, 0.35]	0.04 [-0.16, 0.25]
Conceptual vs Mixed	16 classes 268 pupils	0.23 [-0.01, 0.46]	0.04 [-0.23, 0.30]

## Discussion

From a practitioner or school leader perspective the results of the trial through up a number of questions:

- Would it sometimes be best to only use a procedural or conceptual approach?
- What might be the best approach to preparing students for external tests such as the upcoming times tables test in Year 4?
- Would approaches change if there were no external testing?
- Which approach best fits the needs of the students in my class?
- Would different approaches benefit different year groups?

