Improving times table fluency

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About IEE Innovation Evaluation Grants

The first four IEE Innovation Evaluation Grants were awarded in February 2017. Funded by the Institute for Effective Education (IEE), these grants supported pilot evaluations of innovations of teaching and learning approaches based on the Research Schools Network's goal of improving the attainment of pupils by increasing the use of evidence-based practices.

Since then a further 26 projects have been successful in their application for an IEE Innovation Evaluation Grant, bringing the total number to 30. The applications we received included a wide range of interesting, school-led innovations – from after-school film clubs to improve the creative writing of Year 5 pupils, to the use of audio feedback with Year 12 pupils – and we were really impressed with the thought that applicants had put into how these innovations could be evaluated.

The evaluations are small-scale, and test the kinds of innovations that schools are interested in. This is very much a "bottom-up" exercise, allowing schools to get some indicative evidence behind real-world initiatives. Many evaluations are now coming to an end, and we are starting to publish reports on the findings. It is important remember that these are small-scale projects, often carried out in one school, so it is not possible to generalise their findings. In fact, the main benefit of the Innovation Evaluation projects may be in the process, rather than the findings.

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Executive summary

In 2020, children in Year 4 will be required to take a multiplication tables check (MTC). There is much debate about the need for this test and its format but also about the most effective way to teach and practice times tables, as efficient recall without the need to use precious working memory capacity in calculating tables facts is helpful in making larger multiplication and division calculations and problems easier to solve.

In 2017, we carried out research which concluded that the teaching of times tables may be made more effective by using a conceptual approach, which concentrates on examining the connections and patterns in the tables facts, rather than "business as usual". We theorised that there might be an optimum balance of procedural and conceptual approaches to practising times tables.

Description of the innovation

Pupils had four 15-minute times tables lessons each week. Teachers were provided with conceptual and procedural activities for these lessons: conceptual activities were games that focused on the connections and patterns in tables facts, while procedural activities were games in which pupils practised multiplication facts.

Summary of the evaluation

Thirty-four Year 4 classes (876 children) took part in the evaluation. Classes were allocated to one of five conditions, with each condition using a different balance of conceptual and procedural activities during times tables lessons. The intervention lasted for 12 weeks. Before the intervention started, all participating pupils carried out a simple times tables test comprising of 25 spoken multiplication questions. The same test was repeated as a post-test.

Summary of findings

The results of the trial showed that no one balance of practice activities was more effective than another. We conclude that tables may be best taught by using a balanced approach – teaching both the concepts behind them and practising them in a range of ways with low-stakes testing.

Introduction

There is currently much debate about the most effective way to teach and practise times tables, especially as the government has announced that it intends to introduce a timed, online tables test for children in Year 4 in 2020 (STA, 2018).

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. If children are using their limited working memory capacity to "work out" small multiplication facts as part of a bigger problem, they may not, then, be able to use their working memory to attend to other aspects of the problem. Having "automaticity" of recall of multiplication facts – the ability to draw them from the long-term memory, leaves more of the capacity of the working memory to solve other aspects of a larger problem.

For instance, in the question 234 x 46 using a formal written method, six individual "times tables" products need to be found before the whole problem can be answered.

Many children find recall of times tables facts reasonably easy but find it difficult to recall them in timed tests or in applying them to wider reasoning problems. Thus, finding the best balance of approaches to teaching and practising times tables would benefit both teachers and pupils.

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 simply memory. Other research (Beilock, 2011) suggests that an approach which emphasises timed tests as the main approach to teaching tables facts may discourage children from learning maths for life and lead to "maths anxiety".

In 2017, in association with North West Maths Hub 2, I evaluated the impact of using a completely conceptual approach to teach tables facts – one in which children work on the connections and patterns in multiplication facts rather than simply memorising 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 – for example, three lots of four 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 "business as usual" which, for most, but not all schools in the control group, consisted of regular tables testing.

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 in practising times tables would be helpful.

Research question

The research question was: “**Which balance of procedural and conceptual approaches to practising 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

Sample

Children in 34 Year 4 classes from 21 schools participated in the trial. In total, 876 pupils took part.

The schools were all in the borough of Cheshire East and ranged from one-form entry rural and semi-rural primary schools to three-form entry primaries in large towns. They also varied from schools with few children in receipt of Pupil Premium to schools with more than 60% of the children in receipt of Pupil Premium.

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 research team were: Mark Avis (Director of Maths, Aspire Educational Trust), Kate Bond (Assistant Principal, Underwood West Academy), Helen Wright (Wilbraham Primary School – test marking only) and Megan Dixon (Director of Literacy, Aspire Educational Trust – recording of the test only).

Assignment to condition

Five groups of four or five classes were constructed by matching the pre-test scores on a 25-item tables test and the percentage of children in receipt of Pupil Premium. All groups had similar pre-test scores and similar percentages of children in receipt of Pupil Premium. These groups were found to be sufficiently statistically similar using Analysis of Variance (ANOVA).

Innovation

Following the pre- test and assignment to five groups which were statistically similar in pre-test scores and percentages of pupils in receipt of Pupil Premium, each group had a times tables practice session four times a week for 15 minutes per session. In each group, a different ratio of procedural to conceptual tables practice activities was used. The sessions were led by the class teacher. The ratios were:

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

(C= condition)

The activities used were contained in a booklet divided into procedural and conceptual activities and all teachers had one training session on using the materials. None of the individual activities were timed.

The conceptual activities were those used in the original 2017 trial – card and other games based on the connections and patterns in the times tables as outlined earlier. Each times table had six cards. There was always a card showing the tables fact and its reverse, for example, 2 x 3 = and 3 x 2 =. The other images showed either repeated addition (eg, 4 + 4 + 4) or an image showing, say, four squares or a number line showing, for example, four jumps of four or varying arrays (arrays of dots, Numicon type images, dominoes, etc).

The procedural activities were games and other activities which required children to practise tables but not in the form of a timed test, such as paired games, dice games and board games.

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

The trial ran for the summer term of 2018.

The intervention ran for 12 weeks.

Ethics

Consent was gathered from headteachers and classroom teachers and an information letter was sent to the parents and carers of the children in all of the classes explaining the trial and that they could opt for their children’s data to be excluded from the trial and for their child to be excluded from the pupil questionnaire.

All data was anonymised and it was not possible to link data to individual pupils.

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

Outcome measures

Children in all participating classes were given a pre-test two weeks before the beginning of the evaluation consisting of 25 simple tables questions which had been recorded. The recording was played to the class. After an initial question to ensure that children understood where to write the answers and what was required in the test, it asked a question – for example, “eight times two” – twice and then gave eight seconds for the children to write the answer in a box on a pre-prepared sheet.

Children wrote their names on the top of the test sheets so that the class teachers could tick a box at the bottom of the sheet which identified whether the child was in receipt of Pupil Premium. The names were removed before being passed to the research team so that individual children in the trial could not be identified.

Approximately two weeks before the end of the term, children retook the same tables test as in the pre-test under the same conditions and using the same materials.

Process Evaluation

Fidelity

Each class was visited once in the trial to ensure that the materials and condition to which each class had been assigned was carried out in the way envisaged and shown in the training.

These observations were written up and can be read in Appendix A.

They show that all classes using the materials used them broadly in the way in which their use had been envisaged and that teachers and pupils had made some positive adaptations in their use.

Questionnaires

A confidential, anonymous teacher questionnaire was given to gather teacher perspectives on the different approaches (Appendix B) and children also completed a short, anonymous questionnaire to gather their thoughts about the process (Appendix C).

Data analysis

The mean difference in pre- and post-trial scores was collected for each group (condition) for the whole sample and for children in receipt of Pupil Premium. An Analysis of Variance (ANOVA) was undertaken to determine whether any differences between groups were statistically significant. In addition, a comparison was made of the difference in pre- and post-trial scores for schools whose initial scores were below the mean for the whole trial population in order to compare the effect of each condition for children in schools which were initially "lower-attaining".

One school (two classes) was not able to supply post-trial data.

Cost

The cost per pupil of implementing a change in the way that times tables are practised is minimal as the materials (booklets of the different approaches and the cards with the different images, etc) are in the public domain, and using them does not require training (the booklets detail the ways in which the materials should be used and the preparation for using them).

Budget item	Amount
Time for the two programme leads to make the materials and record the tests	£900
Supply costs for each of the teachers involved in the project to be trained in their approach	£2,100
Costs for the two leaders to lead the two training sessions	£900
Travel and costs for the two leaders to carry out the fidelity visits	£5,000
Printing	£400
Administration of the trial, recruitment, etc	£200
Total cost of running the project	£9,500

Results

The results from one of the schools (two classes) in the 100% conceptual group were not received.

Data collected are presented in the tables below.

TABLE 1: A SIMPLE COMPARISON OF THE MEAN INCREASE IN SCORES BETWEEN THE FIVE CONDITIONS (N=876)

Condition Conceptual: Procedural	Mean increase in scores (Correct answers)
Condition 1 4 : 0	1.7
Condition 2 3 : 1	1.5
Condition 3 2 : 2	1.3
Condition 4 1 : 3	1.0
Condition 5 0 : 4	1.3

An Analysis of Variance (ANOVA) was carried out to determine whether the differences between any of the groups were statistically significant for the whole sample and for pupils in receipt of Pupil Premium. The ANOVA did not detect any statistically significant differences between conditions for either group of pupils.

TABLE 2: A COMPARISON OF THE MEAN INCREASE IN SCORES FOR CHILDREN IN RECEIPT OF PUPIL PREMIUM (N=162)

Condition Conceptual: Procedural	Mean increase in scores (Correct answers)	Number of pupils in receipt of pupil premium
Condition 1 4 : 0	1.3	32
Condition 2 3 : 1	1.5	32
Condition 3 2 : 2	1.9	28
Condition 4 1 : 3	1.6	35
Condition 5 0 : 4	1.1	35

TABLE 3: A COMPARISON OF THE MEAN INCREASE IN SCORES FOR CHILDREN IN SCHOOLS WHOSE PRE-TEST SCORE WAS ABOVE AND BELOW THE MEAN. (N=876)

Condition Conceptual: Procedural	Mean increase in scores for schools with **below** mean pre-test scores (16 classes)	Mean increase in scores for schools with **above** mean pre-test scores (18 classes)
Condition 1 4 : 0	3.4	0.6
Condition 2 3 : 1	1.5	2.5
Condition 3 2 : 2	2.8	0.5
Condition 4 1 : 3	1.3	0.9
Condition 5 0 : 4	1.6	0.9

At the end of the trial, children were asked to fill in a short, three-question questionnaire. The results were:

TABLE 4: FIG D: RESULTS OF THE SHORT CHILDREN'S QUESTIONNAIRE POST-INTERVENTION

Did you enjoy learning tables this way MORE or LESS?				
94% of respondents said that they enjoyed this way of learning more and 5.4% said less				
In what way do you think you learn tables best?				
Tests	Playing real games	Playing games on the computer	Singing	Working in books
15%	37%	25%	4%	19%
How often do you think you should have a tables TEST?				
Never	Once a term	Every half term	Weekly	Daily
7%	21%	21%	40%	12%

Process evaluation

In the teachers' questionnaire, a majority of respondents said that they had previously used frequent testing, rote learning and songs or chants as the most common ways of teaching tables.

Most said that they would now use more games and a balance of conceptual and procedural approaches. Teachers in schools where the condition was solely conceptual or procedural said that they would not use that way as the only way to teach pupils.

Some teachers said that a negative aspect of the materials was that they needed to be prepared, for example, printed, cut out, or laminated for frequent use.

Positive comments were:

> "Children enjoyed the cards *a lot*".
>
> "Children have thoroughly enjoyed all the activities and have become more motivated and engaged".
>
> "Seeing children smile while doing times tables (rather than groan or worry) and asking for a times tables lesson on the last week of term says it all really!"

Discussion and limitations

Our previous work compared the effect of a wholly “conceptual” approach with “business as usual” in the teaching of times tables. In a conceptual approach, the concepts underlying tables, repeated addition, commutativity (the “commutative law” for multiplication is that the order in which numbers are multiplied does not affect the product – when multiplying we can swap the order of the numbers and still get the same answer), understanding the inverse and array type patterns, are made explicit and practised. Our previous study suggested that this led to a positive effect on the simple recall of tables facts in a test (Avis, 2017).

In this trial, we wanted to find out if there was an optimum balance of conceptual and procedural approaches to practising the tables facts.

Although there appears to be a slightly greater increase in mean scores for the 4:0 conceptual:procedural (C1) and the 3:1 conceptual:procedural (C2) conditions for the trial population as a whole, the differences are small and not statistically significant.

For children in receipt of Pupil Premium the 2:2 condition (C3) showed the largest mean increase. Comparing the mean increases in the scores for the schools that had a lower mean pre-trial score than that for the trial population as a whole suggested that the 4:0 conceptual:procedural (C1) and 2:2 (C3) conditions were more advantageous.

The increases in mean scores over the trial were relatively small. A limitation of the trial which emerged was that the amount of time given for the children to answer the questions in the pre- and post-test was too long, which resulted in relatively high pre-test scores. Of the pre-test scores, 18% were maximum (25 out of 25). The questions were given orally twice and then children were given eight seconds to write their answer. In contrast, the DfE’s proposed Year 4 multiplication tables check (MTC) will give children six seconds from the moment that the question appears on the screen to answer (DfE, 2018). If the time allowed were smaller, this might have resulted in a greater difference between pre- and post-test scores as fewer children would have achieved the ceiling score in the pre-test.

A further limitation to the trial was that we were not able to link the pre- and post-test scores of individual pupils. On reflection, this could have been achieved by using codes for individual pupils but, at the beginning of the trial, the new General Data Protection Regulations (GDPR) had just been introduced and we were unsure, at the time, of whether or not this would be practical in the context of the regulations.

For schools, there may be two questions to consider:

1. How might we help more children to “pass” the multiplication tables check (MTC) in Year 4?
2. How might we help children to recall tables facts reasonably quickly and accurately in order that they can best apply them to longer questions, problems of different types and as their inverses in division without using too much of their working memory to work them out?

Some may see these as the same task. If children can recall the tables products in six seconds when asked the questions set out randomly on a screen, they should also be able to apply this knowledge to problem solving and division. The Secretary of State for Education who

announced the introduction of the MTC was clear that children should be able to recall the tables facts “off by heart” (DfE, 2016).

Others consider that simply recalling the products quickly in a narrowly focused test does not equate to the ability to apply them to wider mathematical tasks (Boaler, 2015).

The DfE press release which introduced the idea of the MTC was correct to say that, “… there are still thousands of young people starting secondary school without strong maths and literacy skills” but, in reality, many, if not most primary schools never abandoned a “traditional” approach to teaching times tables. It is still very common for schools to use testing, often daily. The format in some schools may have changed to an app or a website but the approach of asking the question and allowing a short amount of time to answer represents the same approach.

There is research evidence to suggest that testing can play a positive part in helping children to learn, to commit ideas and facts to long-term memory (Roediger et al, 2011) but regular tests do not have to replicate the formal of high stakes tests in order to have a positive effect (McDermott et al, 2014).

An interesting comment from a child in one of the fidelity visits was, “The card games [in the conceptual games] help you to work it out and the track games are practice”. This led us to consider whether there is a difference between the way in which tables facts are **taught** and the way that they are **practised**.

Conclusions

The results of our previous trial suggested that teaching times tables conceptually may be more effective than business as usual, which was mostly regular testing. These trial results showed that there was no statistically more beneficial condition with which to practise times tables.

Implications for practice

In order to give children both the best chance of doing well in the Year 4 MTC and helping them to use efficient recall to apply them to a range of mathematical tasks, the most effective approach would seem to be a balanced one. Teach the concepts, patterns and connections in the tables facts and to practise them using a range of conceptual and procedural games and activities which the children enjoy. Regular but not over-frequent low stakes tests and spaced formative tests will help to check which groups of tables facts to concentrate on next.

Further research

Suggestions for further research are:

- What are the most effective ways in which to teach times tables so that they are both recalled fluently in a test situation and applied effectively to a range of mathematical tasks?
- Is there a difference between using a more conceptual approach in the initial teaching phase and practising using a balance of procedural games and low stakes testing and other approaches?

References

Avis M, 2017. Business as usual or a better balance? Aspirer Teaching School Alliance http://www.aspirerteachingalliance.co.uk/attachments/download.asp?file=51&type=pdf Accessed 7.1.19.

Beilock S, 2011. Choke: What the secrets of the brain reveal about getting it right when you have to. New York: Free Press

Boaler J, 2015. Fluency without fear: Research evidence on the best ways to learn math facts. Youcubed. Org

Department for Education, 2016. Press release. https://www.gov.uk/government/news/every-11-year-old-child-to-know-times-tables-by-heart Accessed 5.11.18

McDermott KB, 2014. Both multiple-choice and short-answer quizzes enhance later exam performance in middle and high school classes. *Journal of Experimental Psychology: Applied 20.1 (2014): 3*

Roediger HL, 2011. Test-enhanced learning in the classroom: long-term improvements from quizzing. *Journal of Experimental Psychology: Applied 17.4: 382*

Standards and Testing Agency, 2018. Multiplication tables check assessment framework, November 2018

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

Appendix

Appendix A – Observations from fidelity visits

School A (two classes)

The children were playing a selection of both types of activities as the teacher wanted to show us how they were using both types.

There were good opportunities for co constructing understanding. In one class, I listened to a good discussion including how they might solve 6 x 8 using different approaches and talking about using 2 x 10 for solving 3 x 9.

The teacher said that they liked the hexagon “bingo” type game best. One child said “It’s like a bingo game and it’s easy to learn times tables”.

The classes had made their own procedural games based on the simple ideas behind the ones that they were given ie. track games etc.

The teachers said that they were using the tables squares less to support them now.

When they were playing: How close to 100, the teacher said that they needed to remind them to make arrays rather than simply colouring in that number of squares.

School B (two classes)

In one class they were concentrating on the 6 x table. The teacher showed examples of the cards that they might find and asked children to say what tables fact they were looking at. They had been working on shape and she linked it to that (a hexagon on one of the cards).

She related some of the images on the cards to Pepperoni Pizza which they had played more. She drew out the different aspects of the cards e.g. repeated addition, inverses, arrays etc. They went to find facts that they were given in groups on the cads stuck up around the room.

In the other class, they were working on How close to 100. They had talked through the problem of children not showing their products as arrays but simply filling in that number of squares so the children were using more strategy e.g. one child had really thought about where to put his array in order to reduce the chance of his opponent being able to complete one.

One child said to me, “I like this game best because you get to work out tables and you get to draw them”.

The teacher pointed out that the children were involved in much more discussion and reasoning about tables now and the TA said that one of the children who had answered a question whole class was not usually as confident to answer.

School C

The children were all playing the x7 track game. They said that the track games were their favourite.

They had to get four in a row to win. On the other side of the sheet (laminated on card) was the division version and when they finished the multiplication version, they went on to that. They had no tables cards or posters to support and most seemed very confident with both games.

One child said, “The card games (the conceptual games (MA)) help you to work it out and the track games are practice”. The teacher said that they began with the conceptual activities on Monday because of this. She said that they hadn’t quite known how to play Snap at the beginning.

School D

The children were playing the hoop game outside using 7 and 8 as the targets. In playing the game, there was a lot of discussion and collaboration with children helping each other to work out the scores. One boy said that he liked the card games best as they “get your mind going”.

School E

All were playing the Blockbuster game. They had made it more difficult by requiring the blocks to “follow on” from each other. I thought that this would make the game really long as it did in the initial design but at least three groups finished within ten minutes. They had discussed strategies such as blocking and were talking about tis as they were playing. They had posters of the tables up for support. They were playing the games very enthusiastically. The teacher said that they took a little while to get used to playing games.

School F

All were playing the x7 track game. One was using a tables sheet for support. In discussion with the children, they liked a range of the games. The teacher said that they hadn’t used any particular pattern to the way that they used the games in terms of an order in which to use the conceptual / procedural ones. I had a good discussion about using doubling to help with one pair and hear another pair discussing the same thing – “If you know that 3 x 7 = 21, you know that 6 x 7 = 42”

School G

They were using the concept cards. They had sets ready in bags for different table sets. They took ten each and placed them face down. They had to put one down each sequentially and say what table fact it represented. If two were the same, they, “snapped” them. I suggested that they could use them face up and when they saw a match, they could choose their match and snap. Children said that their favourite was the tables “dash” game.

The teacher said that she felt that they had got better at their tables.

School H

One class was playing the 8x multiplication game and the other was playing blockbuster. They were not using support. They were aware of the ability to “block” in both games.

School I

The class were playing division track games. They played the game in one pair and then swapped partners. The teacher said that it had helped generally with sociability. One child said, “You can have fun and it helps you to learn your tables”. Another said, “In a test, I get a bit anxious about getting a low score but the games make it fun”. Another said, “It helps because

you have to work them out" and another, I'm not a massive fan of maths but these make it fun so it's easier to learn".

School J

Visited on a "conceptual day" and the children were playing How close to 100. It was the second time they had played the game. The teacher ensured at the beginning of the session that all children understood the rules and understood how they had to build up the arrays.

All children were focused on the games and mainly started off by fitting the arrays into the corners of the grids – working methodically.

"It's fun playing the games"

"3x6 is 3 across and 6 rows"

"To beat him, I have to remember the times tables facts quickly"

Children were also looking at the games from different points of view as some children were able to tell me what they had to roll on their dice to complete their board.

The teacher said that the children loved playing both the procedural/conceptual games.

School J

Class 1

Children were playing with the race track games using 1-6/1-10 dice. The children explained to me that they had to roll the dice, make a total and cover with counters.

"We do this every day either before or after our maths lesson"

"This is our maths magician now!"

Other children were playing "gold rush" and the children were very good at explaining the rules

"we love playing this game"

Class teacher commented that she felt that some of her children had declined in times table knowledge as she felt the games were too unstructured. However there was no timer or pressure for the children to compete against.

Class 2

I noticed that not a lot of higher number dice were being used in this classroom so this could have an impact on the rapid recall of 7, 8, 9, 12 – nobody in this room had a dice going higher than 6.

"These games make you learn"

"They will help you if you are struggling with maths"

"I like gold rush the best"

"I like it because it's a competition"

School K

Children here were playing a combination of Throw 10, multiples board and some of the track games. The teacher had introduced a division track for her highest attaining children to focus on the inverse/create another layer of challenge

All the children were engaged, when I spoke to the different groups, they could explain the rules of the game coherently and they confirmed that they do this daily during their 'key skills' time.

One child wanted to show me a times table book she had created at home and had even included one times table grid which used roman numerals.

The teacher said they were very quick to learn the games; they repeated some of the games initially until they knew them all. Teachers pleased with the progress they felt most of the children had made.

"We roll the dice, my friend rolled a 5 and a 6 so we add them together to make 11 and then we look for a number in the 11 times table"

"If I got 5 and 5, I would do 5x5 which is 25 and move my counter on to the board. That's quite an easy one; I have to think a bit more when it is a 6 or an 8"

"At first, I didn't know my 6's and now I've landed on 6 a few times so it's helped me to get better"

"It's helped me a bit because I write them down in my book…I'm still learning them though"

School L

Class 1

Children in this class were playing How close to 100. When I arrived the teacher was demonstrating using a visualiser how to form the arrays and the rules of the game.

Children were all engaged; teacher and children said they enjoyed the games although the teacher did comment that they used to do quite a bit of place value work when teaching times tables previously so she was missing that element. She did think the children were getting quicker at recall of tables though.

Most of the children were going for the corners of the board first so they had a strategy for completing the game.

When asked if they thought they were better at times tables now:

"Yes, because you're learning the tables whilst playing games"

"Closest to 100 is my favourite game"

"I like Pepperoni pizza because we use white boards"

"I like 'snap' – last week we did 8s and 4s but yesterday I did my 7s, I know my 8s now"

"I'm better now, I wasn't really good before but now I am"

Class 2

In this class a similar demonstration was taking place but the teacher had pulled the children back to the carpet because the children were not filling in the board with arrays but simply crossing off the boxes as they made different totals. Children were being asked to explain how the arrays linked to the times table facts.

Once the game started again, there was a timed element with the teacher reminding the children how long was left throughout. All children were engaged in the game and could explain the rules to me – this class were not working as systematically as the other class.

“The beehive game is the best because it is like a knights and castle game where you have to get to the other side”

“Snap is the best “

“I’ve learnt my 6s and 7s now, I didn’t know them before”

“I know my 6s now but I still want to learn my 7s and 9s”

Teacher commented that the children enjoyed the conceptual games more

School M

Class 1

Children were playing Gold rush

Teacher remarked that the children love the games, they have so much more motivation for time tables and are enthusiastic about tackling the activities. In addition, she felt that their rapid recall was much better.

This class all do the same game each session

“We play this game the most, I think I’ve got much better now”

“I know my 11s and 9s”

“It really helps with times tables. Macy helps me if I don’t know the answers so it’s better working with someone else”

All children were really engaged, working well with each other.

Class 2

These children were playing the race track game

Teacher commented again that there had been an increase in motivation for times table activities, the children love the games and the children enjoyed supporting each other with finding the answers

“It makes you think about the answers”

“Its good fun, better than just doing time tables tests, I’m much quicker at remembering now”

“The track game helps me more with the times tables but 3 rolls is more fun”

“I’m not very good at times tables”

“You just want to win so that makes it exciting”

School N

Class 1

Children in this class were playing a mixture of closest to 100/snap/pepperoni pizza. However not all children were drawing arrays when playing the closest to 100 game.

Teacher found that by providing a variety of activities, she could target specific children. She commented that all the children enjoy the activities but they prefer the conceptual games as opposed to the procedural. She also said “before this, they hated times tables but they have much more enthusiasm now”

When I asked the children, they could all tell me the rules of the game and how they would win.

“It’s fun, it gives you the courage to do better and remember the facts”

“It’s more fun than just writing out the times tables”

“The games make it more competitive, I want to beat him”

Class 2

These children were playing the race track games, all the children were engaged and they were all playing with the same track – 4x table. The usual class teacher was absent,

The children told me that they preferred the conceptual games in particular, pepperoni pizza and snap.

“Now that I’m playing this, I get to see the answers and that helps me”

“I’m better at 7s and 8s now”

“I know 6s, 7s, 8s and 9s now but before I didn’t know the 8s and 9s”

School O

Today they were playing number track games, with children focusing on a mixture of 3, 4, 6 and 8 x tables, all children were engaged. I asked the teacher if she had differentiated the activity in order to target specific children but she said that the children were very self-aware and they were asked to choose a game that had a times table that they needed help with. Teacher thought that playing the games had made a difference and she had noticed it particularly whilst working with fractions as the children were much stronger. The children prefer the conceptual games- pepperoni pizza and snap particularly – so the teacher alternates daily the activities they do to fit the ratio she was asked to complete.

“This game has made it easier to learn times tables as we have to practice more”

“I can’t do times tables so my friend helps me when I’m stuck”

“I’m much better at my 8s now”

“Pepperoni pizza is my favourite because it helps you to see it better”

School P

Today the majority of the class were playing ‘Throw 10’ (P) with a small group of children guided by the teacher playing ‘Snap’ (C)

The school have been thinking of ways they can introduce the times table games to the whole of KS2.

Teacher feels that the games have definitely made a difference to the recall of facts. Both sets of games have engaged the children.

“”Everyone’s got better because it’s fun – you’re playing games so it doesn’t really feel like you are doing real work”

“I can get the answers much quicker now”

“I like it because if I’m stuck, my partner will help me out”

“When you roll the dice and you get 6 and 6, that’s 6x6 which is 36…I didn’t know that before”

Appendix B – Confidential teacher questionnaire

Thank you so much for your participation in the tables trial this term. I would be very grateful if you would fill in this confidential questionnaire and mask school to mail it to me at:

Thanks again.

Having spent a term either using a balance of conceptual and procedural approaches or just one approach, what do you think about:

a. **How you have taught times tables in the past?**

b. **How you might change your approach in the future**

Were the games and activities:

Simple enough?

Adaptable enough?

Are there any changes that you would make to the games and activities?

Have you any further comments on the activities or the process of the trial?

Appendix C – Children's questionnaire

Questionnaire

Please put a tick or cross

Did you enjoy learning tables this way MORE or LESS

More	Less

In what way do you think you learn tables best?

TESTS	PLAYING REAL GAMES	PLAYING GAMES ON THE COMPUTER	SINGING	WORKING IN BOOKS

How often do you think you should have a tables TEST

NEVER	ONCE A TERM	EVERY HALF TERM	WEEKLY	DAILY

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