EFFECTIVE TEACHING AND LEARNING:
DEVELOPMENT PROJECT REPORT

‘Bestimation’
Using basic calculators in the numeracy classroom

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National Research and Development Centre
for adult literacy and numeracy

Published by the National Research and Development Centre for Adult Literacy and Numeracy

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ISBN 978-1-905188-51-2

NRDC is a consortium of partners led by the Institute of Education, University of London (see back cover for a list of members) and is part of the Faculty of Policy and Society at the IoE.
www.ioe.ac.uk

Design: www.chapmandesign.net
Print: dsi colourworks
Cover photo: iStock.com

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This is one of several linked publications arising from the five Effective Practice Studies carried out by the National Research and Development Centre for Adult Literacy and Numeracy (NRDC) from 2003 to 2007. The five studies explored effective teaching and learning in reading, writing, numeracy, ESOL and using ICT.

NRDC has produced three series of publications from the Effective Practice Studies: the research reports, published in February 2007; the practitioner guides, published in partnership with NIACE in Autumn 2007; and the development project reports, published in Autumn 2007. For titles in the first two series, please see the back cover.

These development project reports focus on specific elements of effective classroom practice in these areas:

- Oral reading fluency in adults
- Collaborative writing
- 'Bestimation': Using basic calculators in the numeracy classroom
- Using voting technology for assessment
- Reflection and action in ESOL

Contents

Introduction

Pocket electronic calculators, including those on mobile phones, are a readily-available, cheap, practical resource with the potential to help learners develop a feel for number. However, research (Coben et al. 2007) has shown that calculators are barely used in adult numeracy classes.

Many teachers said they did not use calculators in the classroom because they felt pressured by the format of the national numeracy tests at Levels 1 and 2. They felt that because learners were not allowed to use calculators in the tests, it was more relevant to develop 'pen and paper' calculation skills and to ensure that learners were familiar with written algorithms.

Learners also have mixed feelings about calculators. They may:

- regard using calculators as cheating and even feel that calculators may harm their maths skills
- tend to become over-reliant on calculators for simple calculations instead of developing their own mental strategies
- accept a calculator answer without attempting to judge whether or not it makes sense
- lack strategies for checking whether they have performed the right operation or pressed the correct keys in the correct sequence
- not be sure how to use all the keys on a basic calculator, or how to interpret calculator displays, particularly when a decimal point is involved.

However, if calculators are used imaginatively as part of an integrated teaching and learning strategy that includes developing estimation and problem-solving skills, they provide adult learners with valuable opportunities for self-directed and self-paced learning using realistic learning contexts (Hembree and Dessart 1992). The influential Cockcroft Report on mathematics education noted that:

> the availability of a calculator in no way reduces the need for mathematical understanding on the part of the person who is using it. (DES/WO 1982)

What we did and why

With this in mind we investigated how practitioners use calculators with adult learners to develop these skills. A call was made through a number of local and national organisations for teachers, including the National Centre for Excellence in the Teaching of Mathematics (NCETM) and the Maths4Life websites, to send us some examples of activities and ideas that they had used successfully in their own teaching. In spite of casting our net wide, the response was very small: in those classes where calculators were used at all this tended to be simply for learners to check their answers. Only five teachers sent in examples of a range of calculator work currently being used in their classes.

We have taken what we think are the best of these and included them here. We also suggest some useful sources of information which we hope will provide teachers with new ideas and inspire them to explore how calculators can be used to enhance the teaching and learning process.

'Bestimation'

Estimation means making a sensible rough calculation. Approximation is finding an answer which is precise enough for a specific purpose; this may involve using techniques such as rounding numbers to suitable degrees of accuracy, or identifying a range within which an answer will fall. Calculators can encourage learners to develop skills in combining common sense and approximation techniques to help them make well thought out estimations – to 'bestimate':

> The ability to 'bestimate' is the key ingredient that separates an intelligent calculator user from a mindless button pusher. (Manly 1988)

In order to use calculators efficiently for problem solving, learners need to understand what the problem is about, to know which calculation to use and how to key the information in and make sense of the answers including being able to decide whether the answer they get is realistic.

Suggested activities

The calculator can be a powerful learning tool to:

- develop number sense
- develop skills in the four basic operations (+ - x ÷)

Multiplication activity

These number cards are laid out face up.

100	20	25	30	40	45	50	60	90	100

Player 1 chooses two cards, and multiplies these numbers mentally (the answer may not necessarily be on the playing board). A referee checks this using the calculator. If correct, Player 1 places a counter on the correct circle of the playing board. Player 2 then has a turn.

The winner is the first to get four counters in a straight line in any direction – horizontally, vertically or diagonally.

As learners improve their multiplication skills, they will become more selective about the numbers they choose and develop strategies.

The number cards could be consecutive numbers and the board could have the answers to consecutive numbers, e.g. 17 x 18 = 306.

Target board

4050	4500	5000	1800	4000
2000	250	2250	1200	600
1350	2400	1125	9000	760
500	1500	2700	450	900
3500	1999	1250	2500	3000

- find different ways of using limited combinations of digits and function keys to reach target numbers

Four operations activity

Learners are given a set of digit cards 1 to 10 and also cards with 25, 50, 75 and 100. They throw dice to generate a three-digit number. They then choose six cards and must use the four operations and any or all of the numbers once only to get as close to the target number as possible.

- do 'skip counting' and investigate multiplication tables using the constant key

Skip counting activity

On a basic calculator press 9 + + followed by = = = .
What happens?

What do you notice about the unit digits in the number sequence?

How many different units digits will you get if you keep adding 7 or 3?

Try using the constant function to reach a target number, e.g., use x 4 as constant and select a number to reach target numbers.

- develop estimation and approximation skills

Decimal estimating and multiplying activity

The aim is to make the calculator display the target number 100.

Player 1 enters any number between 1 and 100 into the calculator. Player 2 multiplies this number by another (either a whole number or a decimal number) aiming to make the answer as close to the target, 100, as possible. Player 1 then multiplies the new answer, trying to get even closer to 100.

The winner is the first to get an answer greater than 99 or less than 101 on the calculator display.

Learners should keep a written track of the numbers they have used.

- encourage reasoning, estimation and communication, rather than just 'getting the right answer'

Learners can consider calculations with a choice of estimates for the answer, choose and then check them with a calculator. They can also be asked to make decisions about appropriate degrees of accuracy for answers, e.g., deciding how many decimal places (or how many significant figures) to use in the answer, and how to round answers accordingly.

- deepen understanding of place value

Place value activity

Each player inputs a seven-digit number into their calculator.

You may use the same digit more than once.

A random card is chosen from a set of digit cards numbered from 1 to 9. If this digit appears in the number you have on your calculator, you can change it to zero by identifying its place value, and subtracting the appropriate number using the calculator keys.

If you subtract the correct number, this digit will automatically change to zero.

For every random number, you can only eliminate one digit from your calculator. So if you have, for example, three 2s, you must wait for 2 to come up three times.

The first to reach exactly zero is the winner.

- develop understanding of decimal and negative numbers

Learners can experiment with the +/- keys to calculate differences between positive and negative numbers and also between negative numbers.

- enable the use of very large or complicated numbers
- understand number operations and relationships
- explore and identify mathematical rules, principles and relationships between numbers

Learners understand that, for example, 2/5 also means 2 divided by 5 and hence know how to input fractions into a simple calculator. Learners can experiment with using the % key.

- explore sequences, investigate number patterns and discover rules

Decimal multiplication activity

Use a calculator to do these sums.

What do you notice about the answers?

Are any of them the same?

Can you explain what happens?

346 x 723	=	
34.6 x 723	=	
346 x 7.23	=	
34.6 x 7.23	=	
34.6 x 72.3	=	
346 x 0.723	=	
3.46 x 72.3	=	
0.346 x 0.723	=	

- teach order of operations (BODMAS)

BODMAS is an acronym to help you remember that operations should always be done in the following sequence: Brackets first, then Orders (i.e. powers and square roots), Division and Multiplication before Addition and Subtraction.

Using both basic and scientific calculators, input 4 +3 x 2 =. Compare and discuss answers and experiment further with subtraction and division.

- allow less time on unnecessary calculations and more time exploring mathematical concepts and structures
- solve problems

Learners are empowered to explore complex problems that might otherwise be out of reach.
Learners can use real data and solve real-life problems.

- foster independence and develop confidence

Calculators simplify tasks, reduce reliance on rote memorisation, take the pressure off learners and motivate them to concentrate on developing problem-solving strategies.

Calculation activities

How many ways can you get the number 20 by pressing just five keys? Or by using only the digits 1 to 5?

How many different ways can you find of making the number 24?

Can you make all the numbers between 1 and 24 by adding consecutive numbers, e.g., 4+5 = 9?

- investigate functions

Explore the use of each function key (+ - x ÷ √ %), the memory keys and the constant key. Learners can experiment with a particular key and then explain to others what happens when it is used in different ways.

Calculators can be used effectively in collaborative work. In mixed ability groups they can be an effective leveller, enabling everyone to join in on an equal footing.

Calculators also provide useful opportunities for assessment. Teachers can observe learners' estimation skills and ability to see through to the maths in real-life problems. They can check whether learners have grasped underlying concepts and can select appropriate calculations. Calculators can be used as a self-assessment tool. Learners can check and mark their own and other learners' work. Using calculators provides immediate feedback, and can also be a positive reinforcement which boosts confidence.

Conclusion

Calculators can impact very positively on the teaching and learning of numeracy, and can also be a versatile and highly motivating resource at all levels. It should be remembered, however, that learning how to use a calculator is a skill to be acquired in its own right.

The calculator can be a powerful learning tool to help learners:

- develop number sense
- understand number operations and relationships
- solve problems
- foster independence and develop confidence.

Both teachers and learners should be encouraged to see them as valuable learning tools to be used as and when appropriate by learners and teachers alike.

Learners should have more opportunity to use them appropriately in problem solving and should be supported in making sensible choices about when to use estimation, mental methods, pen and paper, a calculator or a spreadsheet.

Good sources for calculator ideas

Adult Literacies Online
www.adultliteraciesonline.com

BEAM website - Maths of the Month free downloads and *Calculator Skills and Assessment in Years 5 & 6* (BEAM) www.beam.co.uk

BECTA - using ICT in mathematics
http://curriculum.becta.org.uk/docserver.php?temid=89

Maths4Life website www.maths4life.org.uk

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Notes

Notes

Acknowledgements

The ideas, activities and suggestions in this paper were developed by six numeracy practitioners: Fiona Chisnall, Sara Fielder, David Martin, Barbara Newmarch, Sue Nieduszynska and Thelma Soremekun.

This report was peer reviewed by:
Christine Ness, Thames Valley University
Sue Nieduszynska, freelance consultant

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Funded by the Department for Innovation, Universities and Skills as part of Skills for Life: the national strategy for improving adult literacy and numeracy skills.