An early intervention to improve deaf children's mathematics learning

Deaf children underperform in mathematics in comparison to what they should be able to do, given their cognitive abilities. It is often thought that they miss out on many mathematical experiences because learning about mathematical ideas early on requires that children coordinate their attention to actions with a problem solving aim, which is often expressed in language. For example, when a mother is putting something on a plate, she may say "that's too much, I need to take some out" and take some out. She is emphasising the inverse relation between addition and subtraction, and the deaf child may miss out this coordination of the action with the explanation. Hearing children learn many concepts informally before they start school but deaf children might not have the same opportunity. Our previous research has identified three concepts that all children, deaf or hearing, must grasp to some extent before they start learning mathematics. Those children who have difficulty with these concepts, find it a great challenge to learn mathematics in school. The concepts that we aim to test through these materials are related to reasoning, not to calculating. They are:

- additive composition
- the inverse relation between addition and subtraction
- one-to-one and one-to-many correspondences

The learning outcomes described in this document were listed to support teachers in their daily task of thinking about the aims of their lessons in the context of these three ideas. We suggest that you work through all the activities in the order they appear in the teachers' notes.

UNIT 1

Learning objectives	Books	Games	IT Games	Materials required
Monster's Walk Game 1. To introduce numbers as an ordered sequence, not just where you get to in counting. 2. To familiarise children with written numbers. 3. To learn how to 'count on / count back'. Additive Composition 4. To understand additive composition i.e. any number can be composed of two (in this case) or more numbers. To understand relative value through **Exchange** of coins. To understand 1:1 correspondence, and 1: many correspondence (2p coin = 2 x 1p coins). **Comparison** of amounts (2 x 1p for 1 x 2p coin). **Composition** of amounts e.g.1F 5. To learn to use language flexibly.	Teacher Notes (TN) pp.2-22 Booklet 1 pp.2 – 12 **Activity**: Snail (TN p4; Booklet 1 p1A) 2p = 2 X 1p **Activity**: Money Board Base-board (TN p12; Booklet 1I) Booklet 1 pp.2 - 12	(A) Monster's Walk Game (TNp3)	The IT games are designed to be played throughout each Unit. *IT Games 1 – 6*	Monster's Walk Game (See Website Game 1) Board Dice At least 2 different colour counters Snail 2p = 2 x 1p board 14 x 2p coins 28 x 1p coins Money Board Base-board 20 x 1p 10 x 2p coins Dry wipe marker pen Cloth/tissue
Inversion 6. To understand the inverse relation between addition and subtraction in an easier situation (if you add and take away the same things, the quantity does not change) 7. To be able to reason that if you add and subtract the same **number** of blocks to a row of blocks, the original number does not change (the blocks added and subtracted are different). 8. To be able to reason that if you remove more than you added the answer will be 'less'; and if you remove less than you added the answer will be 'more'. N.B. We cover the blocks to encourage reasoning instead of counting; after the child gives the answer, we can remove the cloth as a way of giving feedback.	TN pp.13 - 22 Booklet Final page		*IT Games 7, 13, 17*	Bricks/Unifix: 9 each of two different colours. A cloth to cover bricks Pictures of boxes etc. See Website; Project Resources; Inversion Pictures.

UNIT 2

Learning objectives	Books	Games	IT Games	Materials required
Additive Composition 1. To understand additive composition i.e. that any number can be the sum of two or more numbers. To understand relative value through **Exchange** of coins. To understand 1:1 correspondence, and 1: many correspondence (5p coin = 5 x 1p coins etc.) e.g. Activity 'Butterfly' **Comparison** of amounts (5 x 1p for 1 x 5p coin) e.g. 2C. **Composition** of amounts e.g.2E 3. To learn to use language flexibly.	Teacher Notes (TN pp.3 – 43) Booklet 2 **Activity:** Butterfly (TN p24; Booklet 2 p2A) **Activity:** Money in the bag (TN p33; Booklet 2 p2J) **Activity:** Money 'Bingo' (TN p34; Booklet 2 p2K)		The IT games are designed to be played throughout IT Games 8-14	Butterfly 5p = 5 x 1p board Board 8 x 5p ; 24 x 1p coins Coins: 10 x 5p;10 x 2p;10 x 1p Money in the bag: Picture of/ real bag See Website; Project Resources; Additive Composition Pictures. 10 x 1p; 10 x 2p; 10 x 5p coins Money 'Bingo' activity Base-board for each child A set of cards with amounts written in numbers (e.g.7p, 3p)
Inversion 4. To understand the inverse relation between addition and subtraction Same aims as previously	TN pp35-42) Booklet 2 Final page		IT Games 7, 13, 17	Bricks/Unifix: 9 each of two different colours. A cloth to cover bricks

UNIT 3

Learning objectives	Books	Games	IT Games	Materials required
Inversion 1. To be able to reason that if you add and subtract the same number of blocks to a row of blocks, the original number will be 'the same'; that if you remove more than you added the answer will be 'less'; and if you remove less than you added the answer will be 'more'.	Teacher Notes pp.45 – 61. Booklet 3	'Is it more, less or the same? Board Game (TN p45)	IT Game 13	Board Game 'Is it more, less or the same? (Website Game 2) Board Dice 8 counters of one colour 8 counters of a different colour
Additive Composition 2. To understand that a number greater than one can be composed of two or more numbers. 3. To use language flexibly. 4. To understand how to use counting in different ways to solve word problems.	Booklet 3 (p.3A) **Activity:** Caterpillar (TN p46; Booklet 3 p3A)			Caterpillar Activity Board 40 x 1p 6 x 10p
5. To understand addition and subtraction story problems. 6. To be able to use logical reasoning to know how to count.	Booklet 3 pp.3B-3F; TN pp47-51		IT Games 15 -19	Coins:3 x 10p; 3 x 5p ; 3 x 2p; 5 x 1p;1 number die;1 direction die;Pictures - See Website; Add. Composition Pics.
Inversion 7. To understand the inverse relation between addition and subtraction. 9. To be able to reason that if you add and subtract the same number of blocks to a row of blocks, the original number does not change, irrespective of the end from which the blocks are taken. 10. To be able to reason that if you remove more than you added the answer will be 'less'; and if you remove less than you added the answer will be 'more'.	Booklet 3 pp.3L – 3Q; TN pp55-62)		IT Games 7, 13, 17	Bricks/Unifix: 9 each of two different colours. A cloth to cover bricks

UNIT 4

Learning objectives	Books	Games	IT Games	Materials required
Additive Composition 1. To understand additive composition of 20p using 1p, 2p, 5p,10p, 20p (adding flexibility to how children understand numbers).	Teacher Notes pp.63 – 81 Booklet 4 **Activity:** The 20p challenge(TN p64; Booklet 4 p.4A)		IT Games 15 - 19	The 20p challenge activity Boards (one board per player) Dice Coins per player: 3 x 10p; 6 x 5p; 10 x 2p; 20 x 1p
2. To understand additive composition of numbers and coins (1p, 2p, 5p,10p, 20p). **Composition** of amounts e.g.4B 3. To learn to use language flexibly.	Booklet 4 pp.4B – 4F			Coins: 3 x 20p; 4 x 10p ; 6 x 5p ; 3 x 2p ; 9 x 1p
Inversion 4. To understand the inverse relation between addition and subtraction. (Different colour; different end) 5. To understand the inverse relation between addition and subtraction in picture story problems. 6. To be able to reason that if you add and subtract the same number of blocks to a row of blocks, the original number does not change, irrespective of the end from which the blocks are taken. 7. To be able to reason that if you add more than you subtract, the answer will be greater, and if you subtract more than you added the answer will less.	Booklet 4 pp.4G – 4I Booklet 4 pp.4J – 4K			Bricks/Unifix: 9 each of two different colours. A cloth to cover bricks
Addition and Subtraction Story problems 8. To understand how to use counting in different ways to solve addition and subtraction story problems. 9. To be able to use logical reasoning to guide the way they count.	Booklet 4 pp.4L – 4R			

UNIT 5

Learning objectives	Books	Games	IT Games	Materials required
1. Additive Composition To have practical experience of **Additive Composition** of amounts in 'Can You Buy It?'	Teacher Notes pp.83 – 100 Booklet 5 p.83	'Can You Buy It?' Board Game (TN p83)	IT Games	'Can You Buy It?' Board (Website Game 3) Different coloured counters (25 each for 2 players; 10 each for 5 players) Coins: A selection of: 50p, 20p,10p, 5p, 2p coins A bag /box (for the 'bank')
2. To learn to use language with greater flexibility e.g. 'Which would be the least number of coins you could use?' / 'How much more money does he need to save?' 3. To be able to quickly identify the larger value coin/amount.	Booklet 5 pp.5A – 5F			Coins: 1 x 50p ; 5 x 20p; 5 x 10p; 5 x 5p; 5 x 2p; 5 x 1p Cloth bag
Addition and Subtraction story problems. 4. To understand how to use counting in different ways to solve addition and subtraction story problems. 5. To be able to use logical reasoning to guide the way they count.	Booklet 5 pp.5G – 5L **Activity**: 'Money In The Bag' (TN p89; Booklet 5F)			
Correspondence 6. To understand one-to-many correspondence reasoning, through acting out stories using manipulatives and drawings.	Booklet 5 pp.5M – 5R			Pictures of lorries etc. See Website; Project Resources; Correspondence Pictures.

UNIT 6

Learning objectives	Books	Games	IT Games	Materials required
1. Additive Composition To understand additive composition of numbers and coins (1p, 2p, 5p, 10p, 20p, 50p). 2. To learn to use language with greater flexibility e.g. 'What are the exact coins for the stamp machine?' / 'How much money must he borrow from his friend to pay for his ticket?'	Teacher Notes pp.101 – 116 Booklet 6 pp.6A – 6 F		IT Games	Coins: 1 x 50p; 4 x 20p; 7 x 10p; 3 x 5p; 5 x 2p; 3 x 1p
Inversion 3. To understand the inverse relation between addition and subtraction.	Booklet 6 pp.6G – 6K			Bricks/Unifix: 18 of one colour. A cloth to cover bricks
Correspondence 4. To understand one-to-many correspondence reasoning through acting out stories using manipulatives and drawings.	Booklet 6 pp.6L – 6Q			Pictures of lorries etc. See Website; Project Resources; Correspondence Pictures.

UNIT 7

Learning objectives	**Books**	**Games**	**IT Games**	**Materials required**
Addition and Subtraction Problems 1. To understand how to use counting in different ways to solve addition and subtraction problems. 2. To be able to use logical reasoning to guide the way they count.	Teacher Notes pp.117 – 133	'Get your target number'(TN p.117) Board game	IT Games	'Get your target number' (Website Game 4) Board A Pack of Playing Cards Scoring sheet for each player.
Inversion 2. To understand the inverse relation between addition and subtraction (same colour; different end and in story problems).	Booklet 7 pp.7A - 7F			Bricks/Unifix: 18 of one colour. A cloth to cover bricks Pictures of freezers etc. See Website; Project Resources; Inversion Pictures.
Addition and Subtraction Story Problems 3. To understand addition and subtraction story problems. 4. To be able to use logical reasoning to guide the way they count.	Booklet 7 pp.7G – 7L			
Correspondence 5. To understand one-to-many reasoning through acting out stories using manipulatives and drawings.	Booklet 7 pp.7M – 7R			Cubes. Pictures of children etc. See Website; Project Resources; Correspondence Pictures.

UNIT 8

Learning objectives	Books	Games	IT Games	Materials required
Inversion 1. To understand the inverse relation between addition and subtraction.	Teacher Notes pp.135 – 149 Booklet 8 pp.8A – 8F		IT Games	Bricks/Unifix: 18 of one colour. A cloth to cover bricks
Addition and Subtraction Story Problems 2. To understand addition and subtraction story problems. 3. To learn to use language with greater flexibility e.g. 'Which one is shorter?'/'How many centimetres longer is it?' 4. To be able to use logical reasoning to guide the way they count.	Booklet 8 pp.8G - 8I (TN pp142-144)			
Correspondence 5. To understand one-to-many correspondence reasoning through acting out stories using manipulatives and drawings.	Booklet 8 pp.8J – 8O			Cubes. Pictures of children etc. See Website; Project Resources; Correspondence Pictures.

UNIT 9

Learning objectives	Books	Games	IT Games	Materials required
Correspondence 1. To understand one-to-many correspondence reasoning.	Teacher Notes pp.151 – 164	'Answer the door' Board game (TN p. 151)	IT Games	'Answer the door' game (Website Game 5) Base-boards for each player 1 X 6 double-sided cards for each player Dice Counters or beads
Addition and Subtraction Story Problems 2. To understand addition and subtraction story problems. 3. To learn to use language with greater flexibility e.g. 'Circle the bigger number'/'Make sure that Jim has 2 less than Paul'. 4. To be able to use logical reasoning to guide the way they count.	Booklet 9 pp.9A – 9G			
Correspondence 5. To understand one-to-many correspondence reasoning through acting out stories using manipulatives and drawings.	Booklet 9 pp.9H – 9M			Counters

UNIT 10

Learning objectives	Books	Games	IT Games	Materials required
Addition and Subtraction story problems. 1. To understand how to use counting in different ways to solve addition and subtraction story problems. 2. To be able to use logical reasoning to guide the way they count. 3. To learn to use language with greater flexibility e.g. 'How many more meters does the cyclist in red have to go to finish'.	Teacher Notes pp.165 – 176 Booklet 10 pp.10A – 10E		IT Games	
Correspondence 4. To understand one-to-many correspondence reasoning 5. To learn to use language with greater flexibility e.g. 'How many dogs will get bones?'/ 'How many sweets altogether?'	Booklet 10 pp.10F – 10K			

UNIT 11

Learning objectives	Books	Games	IT Games	Materials required
Correspondence 1. To understand one-to-many correspondence reasoning 2. To be able to use logical reasoning to know how to count. 3. To learn to use language with greater flexibility e.g. 'How many books can she give to each class?'/ 'How many candles are needed altogether?'	Teacher Notes pp.177 – 182 Booklet 11 pp.11A – 11E		IT Games	Counters/cubes x 25 Pictures of faces etc. See Website; Project Resources; Correspondence Pictures.