MIND READER

Think of a number.
Multiply it by 3.
Add 6.
Take away your number.
Divide by 2.
Take away your number.
You have finished with 3.

How does this work?

HELP

Think about what happens **to the number** in the following steps

(and ignore what you add on to it):

- Think of a number.
- Multiply it by 3.
- Take away your number.
- Divide by 2.
- Take away your number.

NEXT

Invent your own number trick and try it out to see if you can impress your friends.

NOTES FOR TEACHERS

MIND READER	**SOLUTION** Not Magic- Just Algebra
Think of a number.	Call the number n
Multiply it by 3.	3n
Add 6.	3n + 6
Take away your number.	2n + 6
Divide by 2.	n + 3
Take away your number.	3
You have finished with 3.	
How does this work?	Whatever the value of n the result is always 3

Diagnostic Assessment This should take about 5–10 minutes.

1. Write the question on the board, say to the class:
   "Put up 1 finger if you think the answer is A, 2 fingers for B, 3 fingers for C and 4 fingers for D".

> You think of a number and add 5 and your answer is 9. Your number was:
>
> **A. 14** **B. 4** **C. 2** **D. It's impossible to tell**

2. Notice how the learners responded. Ask a learner who gave answer A to explain why he or she gave that answer and DO NOT say whether it is right or wrong but simply thank the learner for giving the answer.
3. Then do the same for answers B, C and D. Try to make sure that learners listen to these reasons and try to decide if their own answer was right or wrong.
4. **Ask the class again to vote for the right answer by putting up 1, 2, 3 or 4 fingers. Notice if there is a change and who gave right and wrong answers.** It is important for learners to explain the reason for their answer otherwise many learners will just make a guess.
5. If the concept is needed for the lesson to follow, explain the right answer or give a remedial task.

The correct answer is B because 4 + 5 = 9 and 9 – 5 = 4 .

A. Learners giving this answer have not understood the question. Y=They have just added the numbers given.
B. Correct answer
C. May be a guess
D. Learners giving this answer do not understand that addition and subtraction are inverse operations.

https://diagnosticquestions.com

Why do this activity?

These activities provide a gentle introduction to writing algebraic equations and to functions and also, for older learners, give a way to revise previous work on functions and inverse functions. Learners need a lot of practice in thinking algebraically and these activities provide practice in an undemanding and playful way.

Learning objectives

In doing this activity students will have an opportunity to:

- Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language
- Determine input values, output values or rules for patterns and relationships using:
  - flow diagrams
  - formulae
- Develop the concept of a function as a rule for giving one output for each input.

Generic competences (some suggestions, select from list or write your own)

In doing this activity students will have an opportunity to **think mathematically,** reason logically and give explanations.

Suggestions for teaching

Start with the first activity and repeat it a few times until the learners are convinced that, whatever number they start with they always get the answer 3. Ask learners to explain why this happens. If they don't spontaneously suggest using algebra you could use the three empty boxes method (packets from your kitchen) and some stones as counters to encourage algebraic thinking.

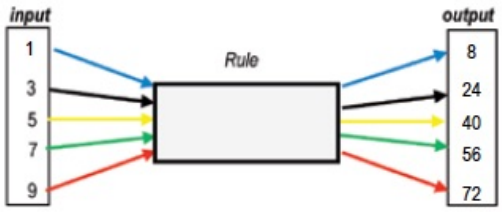
- Ask a learner to think of a number and to put that number of counters into each of the boxes. In each box is the secret number of counters
- Take one box.
- Multiply it by 3, so set out three boxes, shake to show they each have counters inside.
- Add 6. Next to the three boxes set out 6 extra counters.
- Take away the secret number, so take away one box
- Divide by 2? Halve the number of boxes and the number of counters.
- Take away the secret number?

You could ask one of the learners to demonstrate this and, if you are lucky you will all end up with just three counters.

Suppose you write *x* for the secret number. At this point the teacher can ask the class to write down the algebraic expression for each step, perhaps repeating the action with the boxes and counters.

You can suggest that they could amaze their friends and family with this trick!

Then change the rule (the sequence of operations) so that again you always get the same answer, and ask the learners to explain how the second trick is done.



Then play the **Function Game** as an extension of this **Mind Reader** activity. What is the rule (or function) that gives the outputs corresponding to the inputs shown in the diagram mapping 1 to 8 and 3 to 24 etc?

To play the Function Game, the teacher thinks of a function, the learners suggest numbers (inputs) and the teacher telling them that she is doing the same operations each time to their number, writes the outputs on the board. The learners have to guess what rule the teacher is using (what function). When a learner thinks she has guessed the rule the teacher gives her an input and if the learner gives the corresponding output the teacher tells her she is correct. The game continues until several of the learners have guessed the rule and then one of the learners explains to the class how she found it. For example if the function is **x □ 3x+5** then **2 □ 11, 3 □ 14, 10 □ 35** etc.

Finally ask the learners to make up their own rule or function and draw a flow chart for it like the one above. They could work in pairs or small groups. After they have invented their own function charts they can exchange them with other learners who have to find the rule. Or they can come to the board in pairs and play the role of the teacher in leading the Function Game with the teacher acting as referee.

At the end the teacher should provide a summary of what has been learned giving the mathematical terms function and inverse function.

Key questions

- If the rule is x ➔3x + 5 and the input is 6 what is the output? (give different rules and inputs)
- If the rule is x ➔3x + 5 what does 6 map to? (give different rules and inputs)
- Can you find an algebraic expression for the sequence of instructions given?
- If the rule is x ➔3x + 5 what do you do to the input to get the output?
- If the rule is x ➔ 3x + 5 what do you do to the output to get the input?

Follow up

Function Game https://aiminghigh.aimssec.ac.za/years-7-10-function-game/
Shifting Times tables https://aiminghigh.aimssec.ac.za/years-7-9-shifting-times-tables/

Note: The Grades or School Years specified on the AIMING HIGH Website correspond to Grades 4 to 12 in South Africa and the USA, to Years 4 to 12 in the UK and up to Secondary 5 in East Africa. New material will be added for Secondary 6. The mathematics taught in Year 13 (UK) and Secondary 6 (East Africa) is beyond the school curriculum for Grade 12 SA. For resources for teaching A level mathematics see https://nrich.maths.org/12339				
	Lower Primary or Foundation Phase Age 5 to 9	Upper Primary Age 9 to 11	Lower Secondary Age 11 to 14	Upper Secondary Age 15+
South Africa	Grades R and 1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
USA	Kindergarten and G1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
UK	Reception and Years 1 to 3	Years 4 to 6	Years 7 to 9	Years 10 to 13
East Africa	Nursery and Primary 1 to 3	Primary 4 to 6	Secondary 1 to 3	Secondary 4 to 6