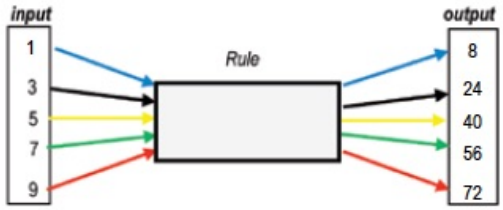
FUNCTION GAME – GUESS MY RULE

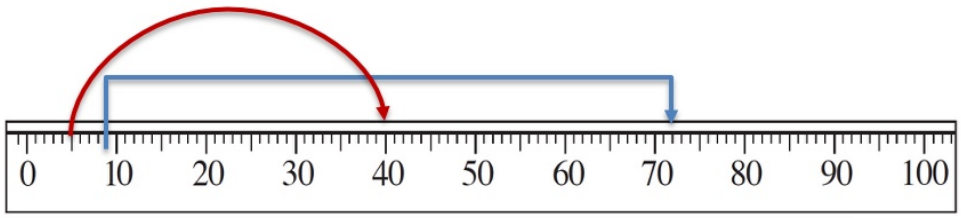
What is the rule (or function) that gives the outputs corresponding to the inputs shown in the diagram mapping 1 to 8 and 3 to 24 etc? This is like translating from one language to another – input English and out comes isiXhosa!



The Function Game is played in silence. Players have to guess the rule in the other player's mind.

The teacher tells the learners that she wants them **to tell her** what she is doing.

She asks the learners to give her numbers and writes them in a column with the outputs for the rule she is thinking of alongside. She asks "What am I doing?" and says "the outputs give clues for finding my rule". She might also show what happens on a number line, like this:



A player who thinks he or she has guessed what the teacher is doing puts up a hand and the teacher suggests a number and asks the learner to do the same with it and give the answer. If the learner gets the right output the teacher congratulates him or her and writes it on the list.

In class, the game continues until about half of the learners have guessed the rule. Then learners who have guessed it explain what the teacher was doing for the benefit of those who did not guess it and the game is repeated with another rule.

For example the rule might be "multiply the number by 3 then add 5".

That gives $\mathbf{2 \rightarrow 11,\ 3 \rightarrow 14,\ 10 \rightarrow 35}$ etc.

Algebraically the rule is called a **function** and written as $\boldsymbol{x \rightarrow 3x + 5}$

FUNCTION GAME FOR 2 PLAYERS

With 2 players, take it in turns to think of the rule and the other player tries to guess the rule with the fewest clues. Have 5 turns each, the player who has made fewest guesses in all wins, and the player who needed more guesses is the loser.

HELP

If 1 → 2 and 2 →4, and 3→6 and 4→8 can you guess the rule?

What about 1 → 3 and 2 →5, and 3→7 and 4→9 can you guess this rule?

Try again to find the rule for the picture in the top box.

AFRICAN INSTITUTE FOR MATHEMATICAL SCIENCES
SCHOOLS ENRICHMENT CENTRE (AIMSSEC)
AIMING HIGH

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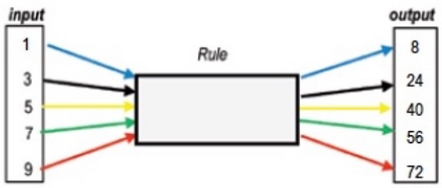


What is the rule (or function) that gives the outputs corresponding to the inputs shown in the diagram mapping 1 to 8 and 3 to 24 etc?

This is like translating from one language to another – input English and out comes isiXhosa!

ACTIVITY FOR ALL AGES

The Function Game is played in silence.

Players have to guess the rule in the other teacher's mind.

The teacher tells them that she wants them **to tell her** what she is doing.

She asks the learners to give her numbers and writes them in a column of inputs. For each input she writes an output for the rule she is thinking of alongside. She asks "What am I doing?" and says "the outputs give clues for finding my rule".

She makes the rule simple for young players and more complicated for older players. Other players can take the teacher's role.

NEXT VARIATION TO INVERSE FUNCTIONS

When we think '+7 and -7 days' for this time next week or this time last week and '+12 and -12 months' for forwards and backwards in years and '+24 and -24 hours' for tomorrow and yesterday – forward and back 24 hours on the clock, we are thinking of functions and their inverses without knowing exactly what the process is called.

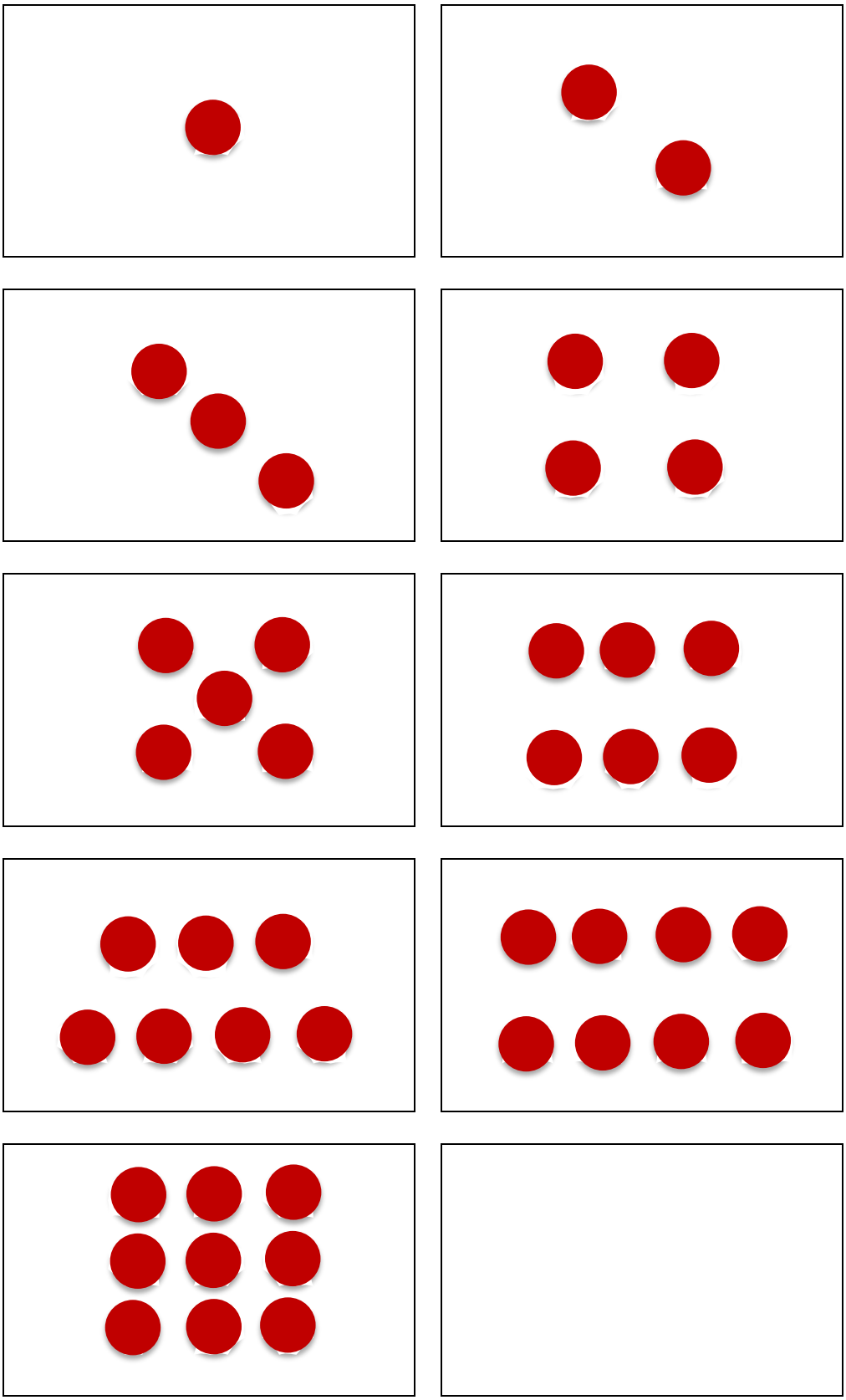
COMBINATIONS OF FUNCTIONS

Think about this example: for the function 'multiply by 3 then add 5' (written $x \rightarrow 3x+5$), if the output is 41 how do you find the input? You first undo the 'add 5' by subtracting 5, then undo the 'multiply the number by 3' by dividing by 3 which gives the input 12. The inverse function is $x \rightarrow (x - 5)/3$. Investigate what happens when other functions are combined with their inverses and answer the question: **What happens when you combine a function with its inverse function?**

THE INVERSE FUNCTIONS GAME FOR 2 PLAYERS.

Player 1 gives the outputs and guesses the function and its inverse function. Player 2 (thinking of both a function and its inverse function) writes Player 1's number in the ouput column and the corresponding number in the input column. This continues until Player 1 guesses the rule and gets his total number of guesses as his score. Then the two players exchange roles. The players have 5 turns each, the player who has made fewest guesses in all wins, and the player who needed more guesses is the loser.

1	2
3	4
5	6
7	8
9	0

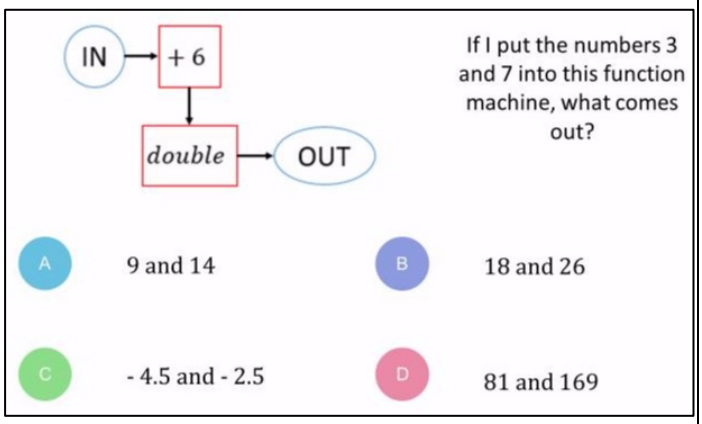


NOTES FOR TEACHERS

Diagnostic Assessment This should take about 5–10 minutes.

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 for D".



1. 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.
2. It is important for learners to explain the reason for their answer, it helps them to sort out their ideas and improve their communication skills.
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 to vote again 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.**

The correct answer is B. **3 → 9 →19 and 7→13 →26**

A. These learners have added 6 to the first number and doubled the second number.
C. Perhaps some halving has been done here instead of doubling.
D. These learners have squared instead of doubling.

https://diagnosticquestions.com

Why do this activity?

By playing this game learners will learn about functions and inverse functions, and they will practice finding the formulas in an enjoyable way. By asking "What am I doing?" the teacher can introduce functions ***without using any technical language*** and then later she can introduce and use the words 'rule', 'input', 'output', 'function' and 'inverse function'. After that frequent use of these terms while playing the game will help the learners to learn the mathematical language. These games can be played many times for a short while each time, to provide a gentle introduction to functions and also, for older learners, as 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:

- learn about functions in a playful way;
- experience a ***gradual*** introduction to the mathematical language used in discussing functions;
- practise thinking algebraically;
- practise making and testing conjectures.

Generic competences

In doing this activity students will have an opportunity to:

- **think mathematically,** reason logically and give explanations;
- **exchange ideas**, think critically, present ideas to others and record ideas effectively.

Suggestions for teaching

Play the Function Game as described above. With younger learners play it several times before gradually introducing the mathematical language. Also with younger learners play the game often and only introduce the variation with inverse functions in a later lesson.

You could 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.

Finally the teacher should provide a summary of what has been learned giving the mathematical terms: rule, input, output, function and inverse function.

FOR OLDER LEARNERS - VARIATION TO INVERSE FUNCTIONS

The game can be varied by sometimes using the numbers suggested by learners as inputs and sometimes as outputs, the teacher writing the numbers in the appropriate input and output columns. This can lead to a class discussion of inverse functions.

For example, for the function $x \rightarrow 3x+5$, if the output is 41 how do you find the input? You undo the "multiply the number by 3 then add 5" by first subtracting 5, then dividing by 3 which gives the input 12. The inverse function is $x \rightarrow (x - 5)/3$.

Key questions

- What am I doing?
- If I give you the number 5 can you do the same and give me the answer?
- Can you explain in words what I am doing with your numbers?

***For older learners*:**

- Now can you explain that with a formula?
- If the rule is $x \rightarrow 3x + 5$ and the input is 6 what is the output? (give different rules and inputs)
- If the rule is $x \rightarrow 3x + 5$ what does 6 map to? (give different rules and inputs)
- If the rule is $x \rightarrow 3x + 5$ what do you do to the input to get the output?
- If the rule is $x \rightarrow x + 5$ what do you do to the output to get the input?

Follow up

Function Flow https://aiminghigh.aimssec.ac.za/function-flow/
Swop https://aiminghigh.aimssec.ac.za/swop/
Building Functions https://aiminghigh.aimssec.ac.za/building-functions/
Undoing https://aiminghigh.aimssec.ac.za/undoing/

Go to the **AIMSSEC AIMING HIGH** website for lesson ideas, solutions and curriculum links: http://aiminghigh.aimssec.ac.za
Subscribe to the **MATHS TOYS YouTube Channel**
https://www.youtube.com/c/mathstoys
Download the whole AIMSSEC collection of resources to use offline with the AIMSSEC App see https://aimssec.app Find the App on Google Play.

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 school years up to Secondary 5 in East Africa.
New material will be added for Secondary 6.
For resources for teaching A level mathematics (Years 12 and 13) see https://nrich.maths.org/12339
Mathematics taught in Year 13 (UK) & Secondary 6 (East Africa) is beyond the SA CAPS curriculum for Grade 12

	Lower Primary Approx. Age 5 to 8	Upper Primary Age 8 to 11	Lower Secondary Age 11 to 15	Upper Secondary Age 15+
South Africa	Grades R and 1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
East Africa	Nursery and Primary 1 to 3	Primary 4 to 6	Secondary 1 to 3	Secondary 4 to 6
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