Everyday Sequence Algorithms

Teachers introduce the concept of sequences by giving pupils simple everyday examples, such as that found on the left, that pupils are expected to follow and then write their own examples for their learning partners to follow. Teachers extend the examples to include moving and turning language such as that found in the middle example. Final examples, such as that illustrated on the right, might use mathematical language if it is appropriate to the childs mathematical development.

Stand	Stand in an empty space	Walk 3 steps
Sit	Move one step forwards	Turn right 90 degrees
Wave	Turn right quarter turn	Move backwards 1 step
Smile	Move one step forwards	Turn left 90 degrees
Bow	Turn left quarter turn	Wait 2 seconds
Jump	Move one step forwards	Walk 3 steps

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Right angle shape algorithms

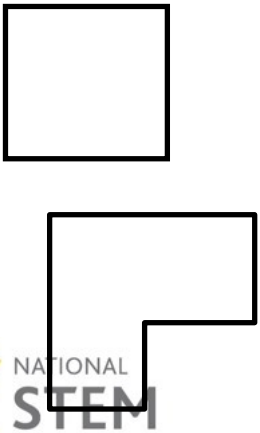
Teacher or pupil draws simple right angle shapes such as those found below on the playground in chalk or on the classroom floor in masking tape. Teacher demonstrates recording the shape sequence algorithm by walking the shape using pigeon steps and recording each move. Pupils are instructed to do the same but to record their algorithms on the worksheets provided.

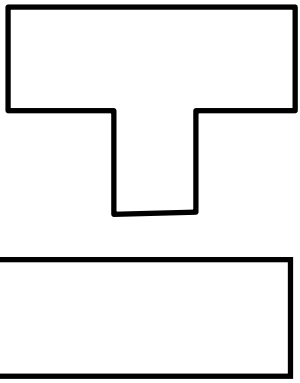
Pupils that struggle with this activity can be instructed to work in pairs taking it in turns to walk and say the algorithm whilst their partners record it on the worksheet.

After a suitable period of time pupils swap worksheets to test each others algorithms for errors.

In a subsequent lesson these algorithms can be turned into code using the chosen programming environment.

Teachers might provide pupils with symbols to speed up recording but should be careful not to mirror the programming language.





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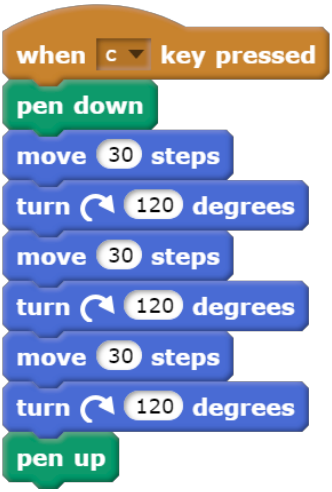
Predict what shape the code will draw

Teachers provide Scratch code samples on cards, such as those shown below, which if run would draw regular 2D shapes. Pupils are asked to predict which shape these are and to justify their choices orally before testing their predictions using Scratch. The process can then be repeated with a new shape.

Pupils are encouraged to walk out the shape dividing the steps by ten and a variety of angles are drawn on the board to aid prediction.

Teachers should give simpler starting shapes to those whose shape knowledge is less secure.



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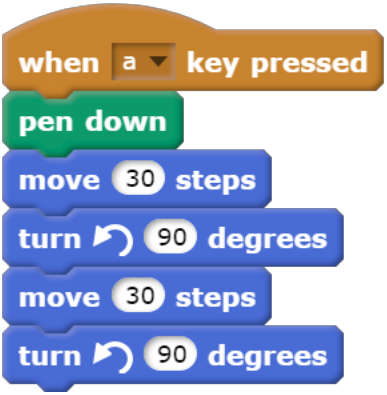
Incomplete shape code

Teachers instruct pupils that some shape code examples, such as those shown below, are missing an unknown number of block commands to complete the shape and return the sprite to its exact starting position.

Can pupils predict what regular 2D shape these code samples will draw when complete and what blocks will be needed to complete the shape and return the sprite to the exact same starting position.

Pupils are encouraged to walk out the initial code dividing the steps by ten and a variety of angles are drawn on the board to aid prediction. Pupils might be reminded that the angles are a part of the outer angle turned rather than an inner angle.

Once pupils have a prediction and have filled in the missing code they can test their conclusion using Scratch before working with another code sample.



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Predict what shape the algorithm will make

Teachers provide algorithm samples on cards, such as that shown below, which if followed by a human would trace common 2D shapes. Pupils are asked to predict which shape these are and to justify their choices.

Pupils are encouraged to walk out the shapes to help their reasoning and a variety of angles are drawn on the board to aid prediction.

Pupils might be reminded that the angles are a part of the outer angle turned rather than inner angles of the shape.

Teachers should give simpler starting shapes to those whose shape knowledge is less secure.

Stand in an empty space

Walk three step forwards

Turn right 120 degrees

Walk three step forwards

Turn right 120 degrees

Walk three step forwards

Turn right 120 degrees

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Incomplete shape algorithms

Teachers instruct pupils that some shape algorithms, such as those shown below, draw an incomplete shape and are missing essential instructions

Can pupils predict what common 2D shapes these algorithm samples will draw when complete and what instructions will be needed to complete the shape.

Pupils are encouraged to walk out the given sequence of instructions and a variety of angles are drawn on the board to aid prediction.

Pupils might be reminded that the angles are a part of the outer angle turned rather than an inner angle.

Walk 3 steps

Turn  90 degrees

Walk 3 step

Turn  90 degrees

Walk 3 steps

Walk 5 steps

Turn  120 degrees

Walk 5 step

Turn  120 degrees

Interpretting algorithms

Teachers give out examples of sequence algorithms or sequence programming on both sides of the page which have questions and answers on one side only.

One pupil asks questions about the algorithm or code and checks the answers and the other answers the questions.

Another card is obtained and the roles are reversed.

Cards can scale in complexity from everyday examples to programming examples.

There is a simple everyday example below.

Stand

Wave

Clap

Bow

Clap

Bow

Bow

Sit

1, Act out the sequence

Answer Did they do the actions starting with stand and finishing with bow in the order shown?

2, Which action is completed the most?

Answer Bow

3, What is the first action?

Answer Stand

4, Is it true that after every clap you need to bow?

Answer Yes

Sequence language

Teachers introduce the word sequence and post a copy of it along with a definition prominently within their classrooms.

They make a point of including it within classroom routines for that week. For example

Can anyone tell me what sequence of instructions you will need to follow to tidy up the classroom?

You will need to pack your books away, tidy up and stack your chairs. Does it matter in what order you carry out this sequence of instructions?

What sequence of calculations will you need, to solve this problem?

NB Sequence in Maths tends to imply a pattern. Pattern is not implied in the computing use of sequence.

Sequence

A set of actions that have a set order

Limited blocks scaffold challenge

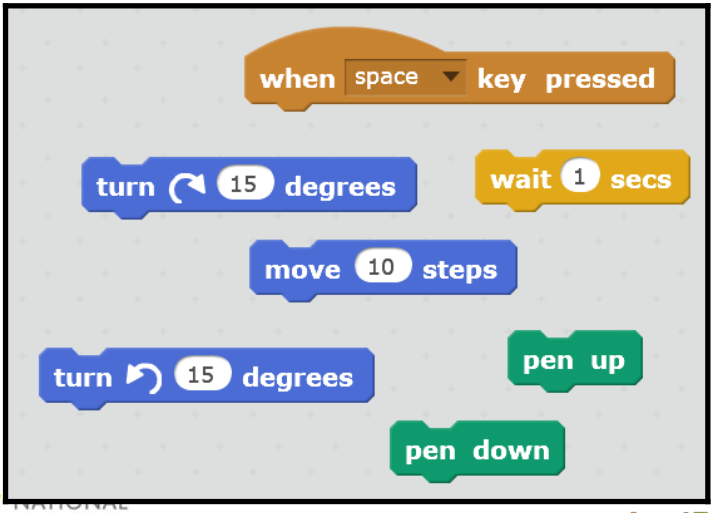
Teachers drag out a limited number of Scratch programming blocks and instruct pupils that these can be used to create a sequence of instructions that will draw regular 2D shapes by snapping them together in order. They can use as many copies of the blocks as they want and they can change the numbers in the blocks. They can't use any other blocks.

Can they program a square?

Can they program a rectangle

Can they program a triangle?

If pupils are struggling to see where they are going wrong they can be encouraged to put a wait after every move or turn to slow the process down.

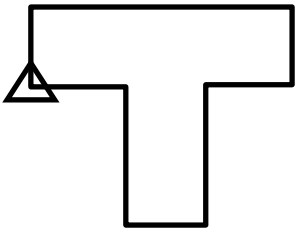


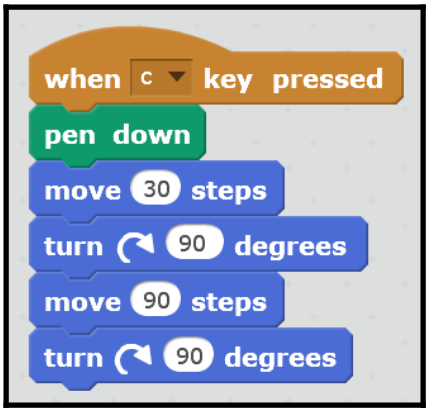
Harder sequence shape algorithm to code

Teachers challenge pupils to draw out a block letter similar to that shown below and create a detailed algorithm for it. They could draw it on paper, use masking tape on the floor or draw it using chalk on the playground.

Once their detailed algorithm is complete they can multiply steps or cm by 10 to help their algorithm convert to Scratch code as a Scratch step in only one pixel (dot) wide

Finally they convert their algorithm into Scratch code.





Start

Start drawing

Walk 3 steps

Turn right 90

Walk 9 steps

Turn right 90

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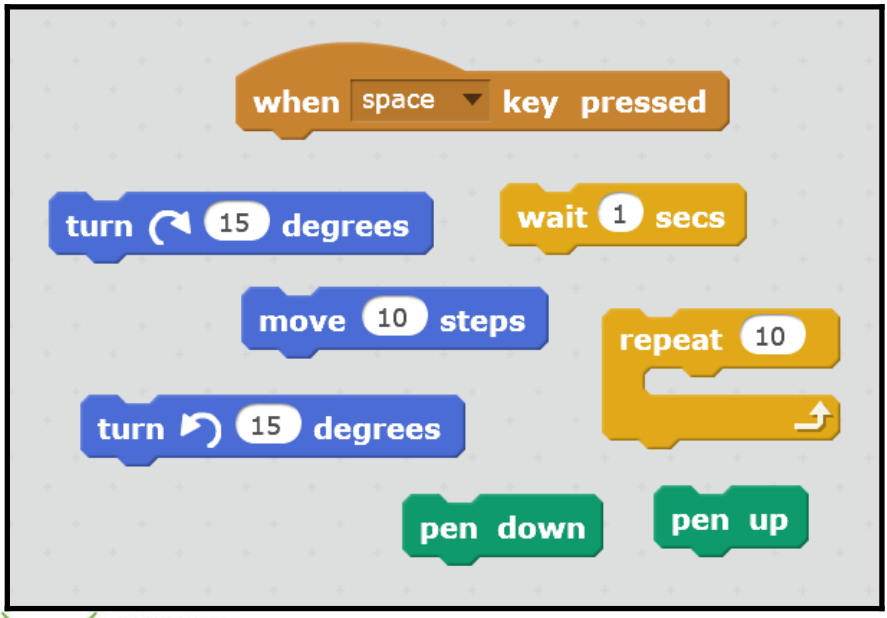
Limited blocks scaffold challenge

Teachers drag out a limited number of Scratch programming blocks and challenge pupils to program regular 2D shapes that use the least programming blocks possible.

Teachers provide the information that pupils can calculate the turns by dividing 360 degrees by the number of sides the shape needs to have.

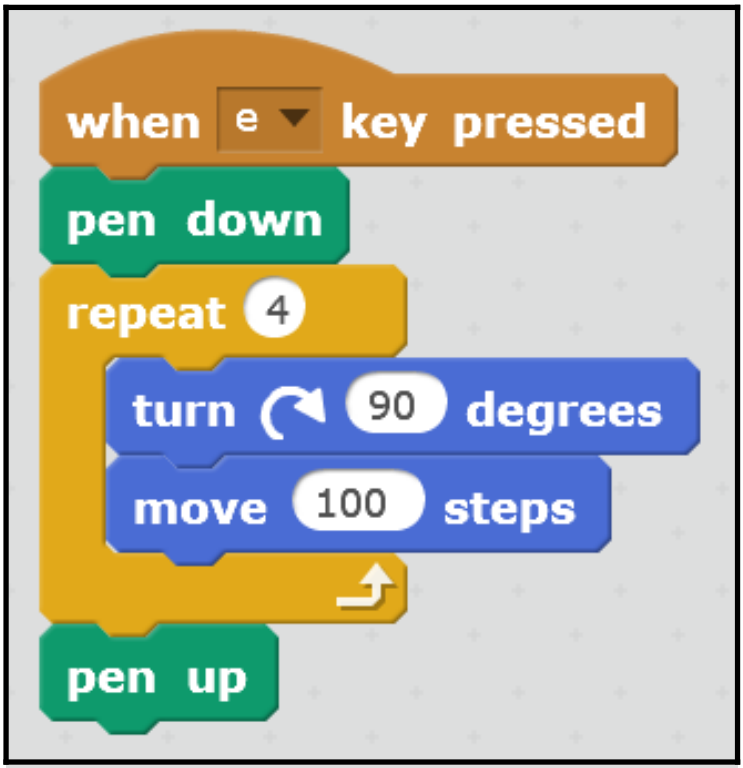
If pupils are struggling to see where they are going wrong they can be encouraged to put a wait after every move or turn to slow the process down.



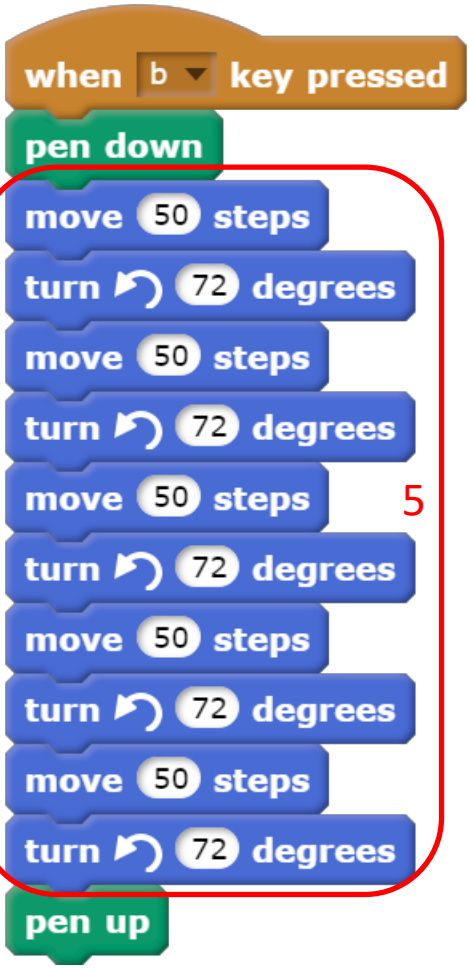
Adapting an example

Teachers create a program to draw a square using Scratch as shown below.

They challenge pupils to create the same program and then copy and adapt it to create other regular sided shapes such as a triangle, pentagon or octagon.



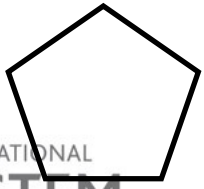
Spot the repeated programming pattern



Teachers ask pupils to study a sequence program of a regular 2D shape like the one shown on the left.

They are asked to find any code that repeats itself and draw around it with a coloured pencil as shown and mark how many times the pattern repeats.

They are then asked to write new shorter code with a count controlled loop.



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Spot the repeated pattern

Start

Start drawing

Walk 5 steps

Turn left 72 degrees

Walk 5 steps

Turn left 72 degrees

Walk 5 steps

Turn left 72 degrees

Walk 5 steps

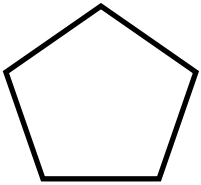
Turn left 72 degrees

Walk 5 steps

Turn left 72 degrees

5

Stop drawing



Teachers ask pupils to study a sequence algorithm of a regular 2D shape like the one shown on the left.

They are asked to find any instructions that repeats and draw a circle round it with a coloured pencil as shown and mark how many times the pattern repeats.

They are then asked to write a new algorithm with a counted loop such as the one shown below.

Pupils may turn this into code.

```
Start drawing
loop 5 times
        Walk 5 steps
        Turn left 72 degrees
Stop drawing
```

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Read and interpret the algorithm

Teachers show pupils examples of shape algorithms, as shown below, and ask pupils to read the instructions and predict what shape they will draw as well as identifying which parts will be repeated. Pupils could also be asked to explain their reasons.

```
Start drawing
Loop 3 times
    Walk 3 steps
    Turn right 120 degrees
Stop drawing
```

```
Start drawing
Do 5 times
    Walk 5 steps
    Turn left 72 degrees
Stop drawing
```

Pentagon

Repeated

```
Start drawing
do 6 times
    Walk 3 steps
    Turn left 60 degrees
Stop drawing
```

```
Start drawing
Loop 4 times
    Walk 4 steps
    Turn left 90 degrees
Stop drawing
```

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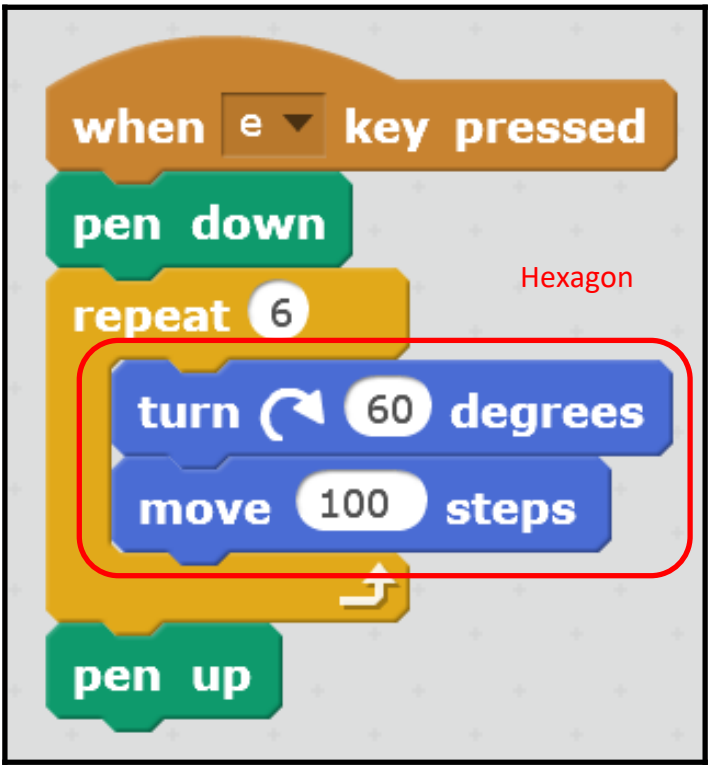
Read and interpret the code

Teachers show pupils examples of shape programs, as shown below, and ask pupils to read the code and predict what shape they will draw as well as identifying which parts will be repeated. Pupils could also be asked to explain their reasons for their shape choice.



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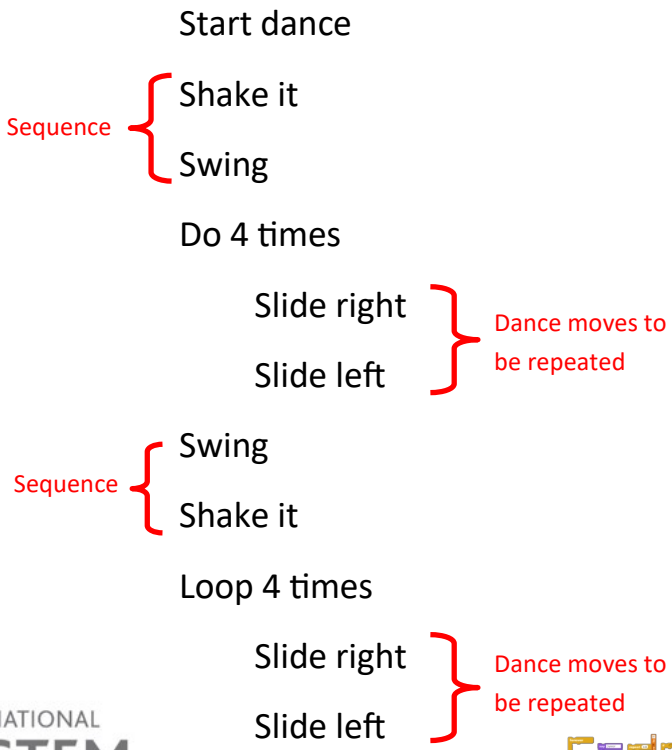
Introducing loops using dance moves

Teachers ask pupils to show them a few of their most popular dance moves. Pupils and teachers give them a name.

Teacher demonstrates how the basic dance moves can be repeated through a count controlled loop where the indented lines indicate what is part of the loop.

Pupils dance the teachers example and then design their own dances for their friends to try which would include sequences and loops.



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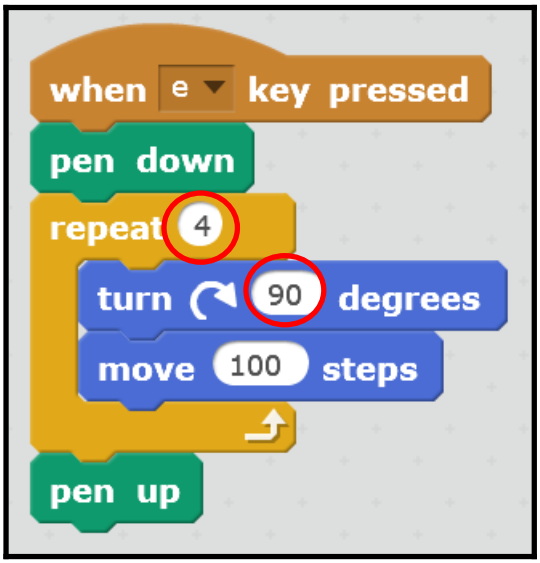
Investigate

Teachers give pupils a challenge card with a programming problem to investigate.

Josh says, “To find the outer angle for every regular shape divide 360 degrees by the number of sides.”



Adapt this program to test Joshes' theory.

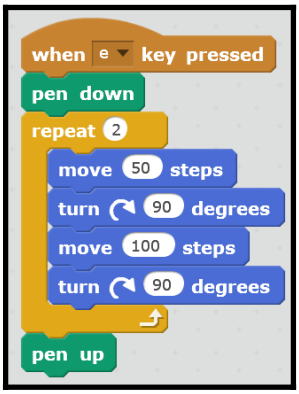
This square has four sides so 4 divide by 360 = 90

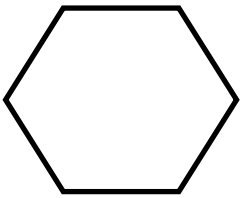
So it works for this example but will it work for other shapes?

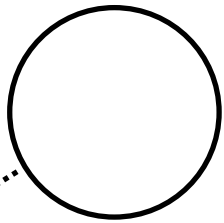
Match the shape to the code

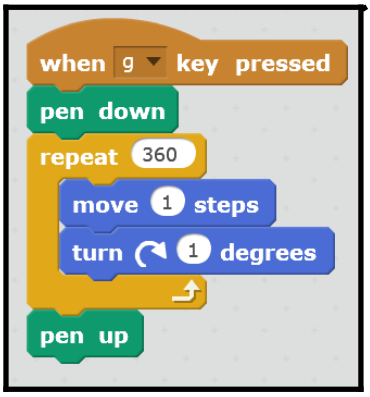
Teachers give pupils a sheet with shapes drawn on one side and the programming to create the shapes on the other side. Pupils need to read the code and draw a line to connect the right shape to the programming that draws it.

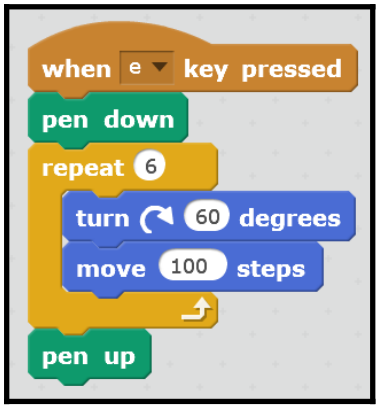
There are a few examples underneath.











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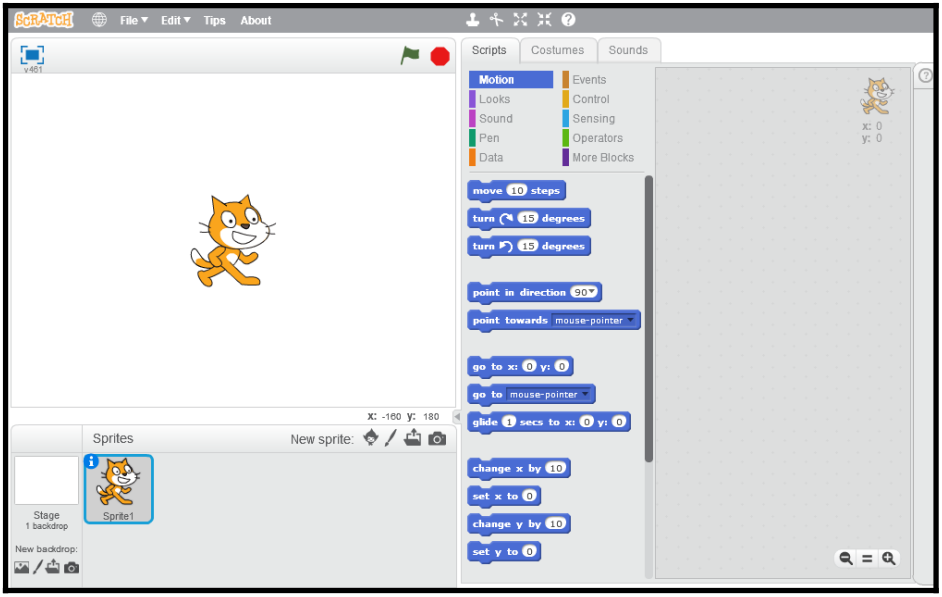
Tinkering time

Teachers give pupils time to experiment with Scratch code that moves, turns and draws. No scaffolding is provided or indication of best code blocks to use. What can pupils come up with themselves before any teacher input?



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Nested loop language

Teachers introduce the word nested loop and post a copy of its definitions prominently within their classrooms.

Nested Loop

A loop within another loop

Loop

A sequence that starts again from the beginning once it finishes

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Repetition language

Teachers introduce the word loop and repeat and post a copy of their definitions prominently within their classrooms.

Teachers find amusing ways to use loop and repeat with their class throughout the week in written and oral commands.

Repeat 3

Pull chair out

Tuck chair in

Loop 5 times

Clap

stamp

Repeat

An action that is done more than once

Loop

A sequence that starts again from the beginning once it finishes

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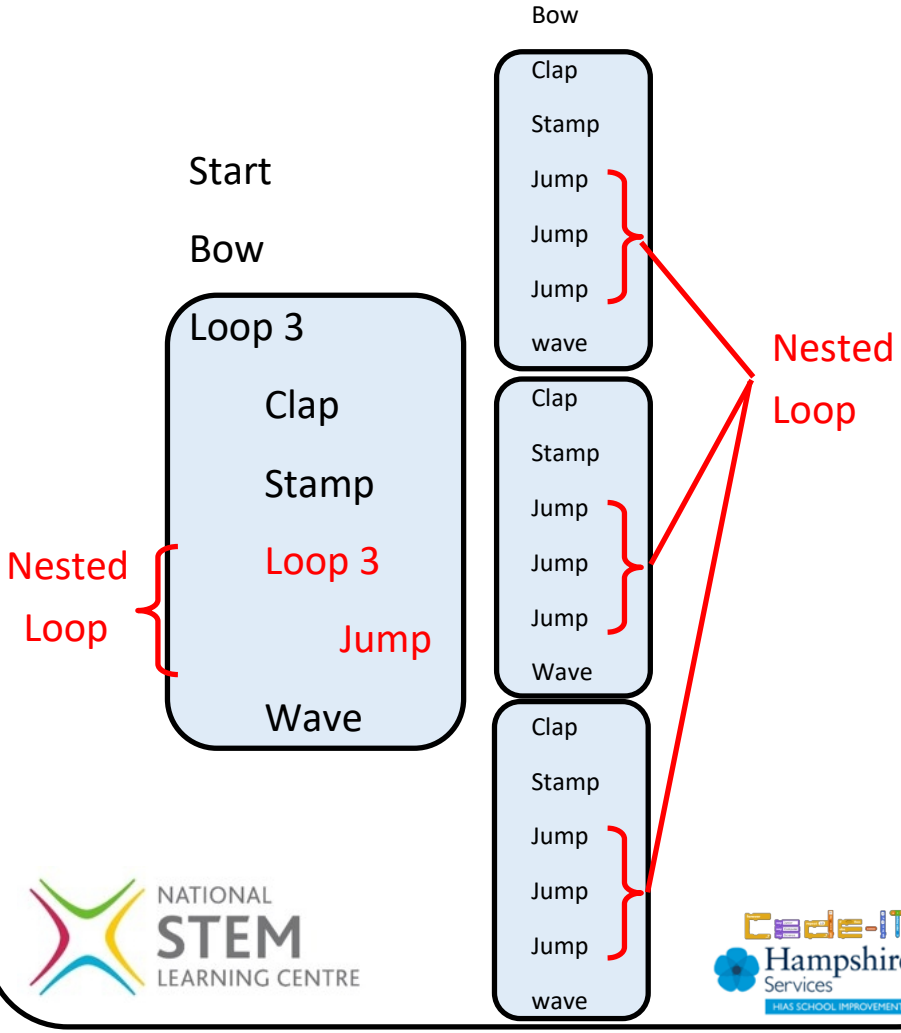
Everyday nested loop algorithms

Teachers introduce the idea of one loop being inside another loop through the use of role play. Pupils are also asked to list the actions in order either orally or written as shown below.

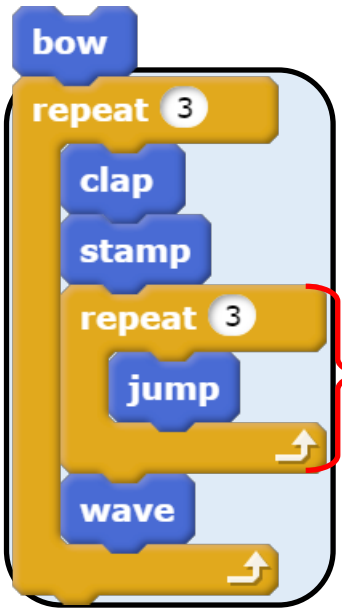
Pupils are also asked to write their own everyday nested loop and test it on their learning partner.



Everyday nested loop programs

Teachers introduce the idea of one loop being inside another loop through the use of role play. Pupils are also asked to list the actions in order either orally or written as shown below.

Pupils are also asked to write their own everyday nested loop and test it on their learning partner.



Nested Loop

Bow
Clap
Stamp
Jump
Jump
Jump
wave

Clap
Stamp
Jump
Jump
Jump
Wave

Clap
Stamp
Jump
Jump
Jump
wave

Nested Loop

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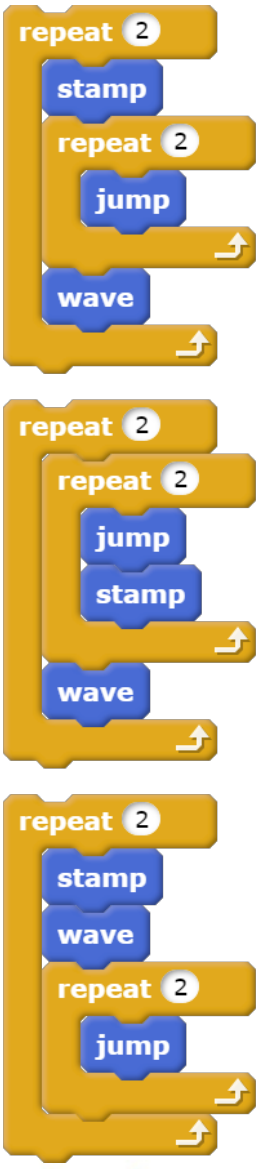
Match the nested loop to its outcome



Pupils are instructed to match the nested loop to its outcome. Often used as a lesson starter or as part of introducing nested loops to novice programmers

Stamp
Wave
Jump
Jump
Stamp
Wave
Jump
Jump

Jump
Stamp
Jump
Stamp
Wave
Jump
Stamp
Jump
Stamp
wave

Stamp
Jump
Jump
Wave
Stamp
Jump
Jump
wave

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Nested loop multiplier effect

Teachers introduce the concept that you can calculate how many times an action or effect is carried out by multiplying all the count controlled loops multipliers that it is in.

Pupils can either test this in an algorithm or a program.

```
Start
Bow
Loop 3
    Clap
    Stamp
    Loop 3
        Jump
    Wave
```

```
Bow
Clap
Stamp
Jump
Jump
Jump
wave
Clap
Stamp
Jump
Jump
Jump
Wave
Clap
Stamp
Jump
Jump
Jump
wave
```

Jump is within two nested repeat 3 loops.

So 3 x 3 = 9 jumps

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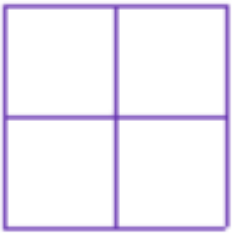
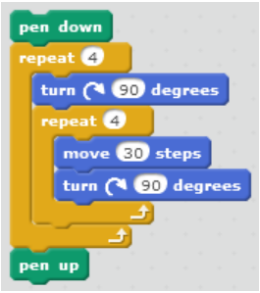
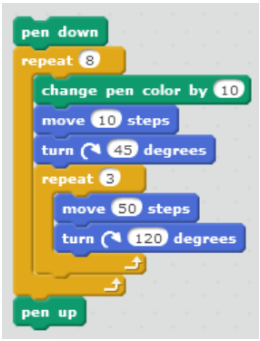
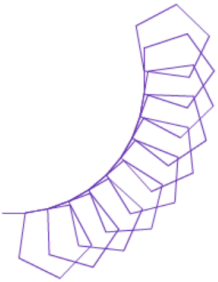
Match the nested loop program to its shape

Pupils are instructed to match the nested loop to its outcome and explain their reasoning. Can also be used as an assessment.









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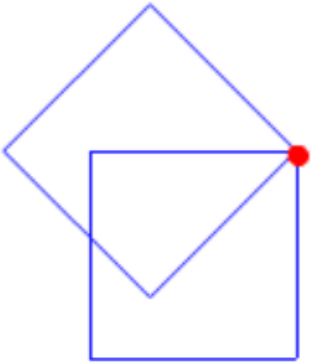
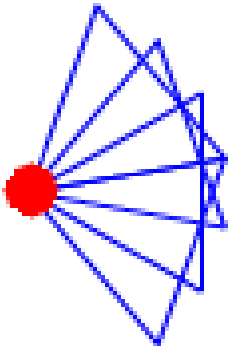
Write an algorithm to create the pattern

Pupils are given an increasingly more complex set of patterns and are instructed to write an algorithm to draw the pattern. They can then test it in Scratch before writing an algorithm for the next shape. A variation of this includes some part solved algorithms.



```
Start drawing
Loop 2
    Loop 4
        Turn right 90
        Walk 50 steps
    Turn right 45
Stop drawing
```



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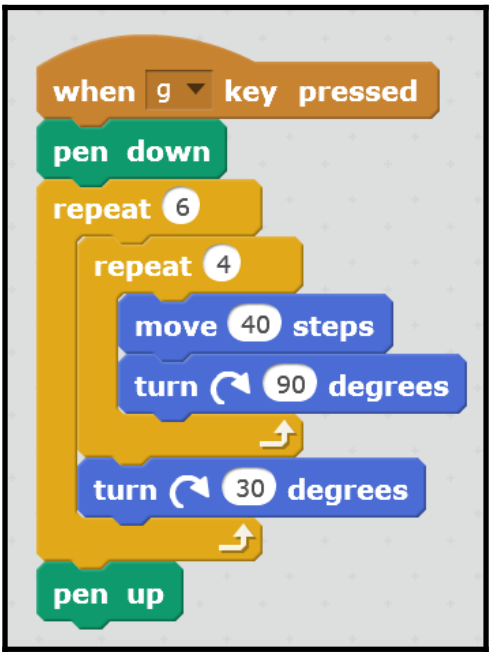
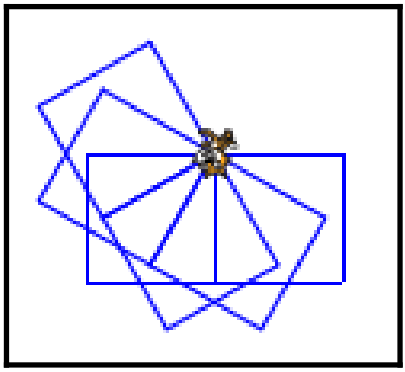
Teacher example followed by pupil adaptation

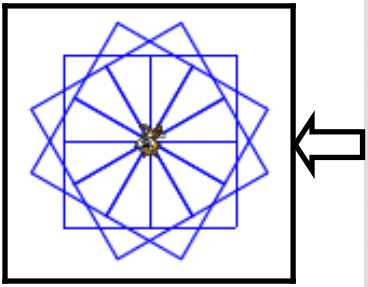
Teachers show pupils how a nested loop can be used to create a repeated pattern. Pupils then use this knowledge to create their own repeated patterns. An example is shown below. Teachers can then ask pupils if they can complete the pattern as a first task.

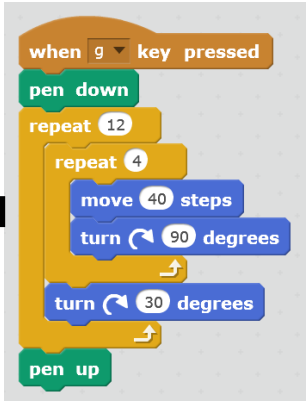


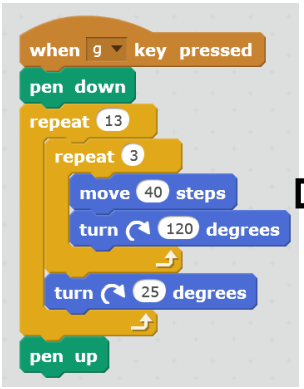


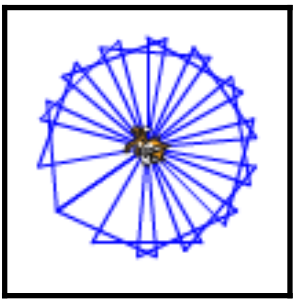
Flower challenge

Pupils are shown how a nested loop can be used to repeat a shape. They are instructed to create a flower pattern using nested loops and any other programming tools. The shape must create a complete pattern and not over draw. Overdrawing is where the pattern continues for more than 360 degrees.





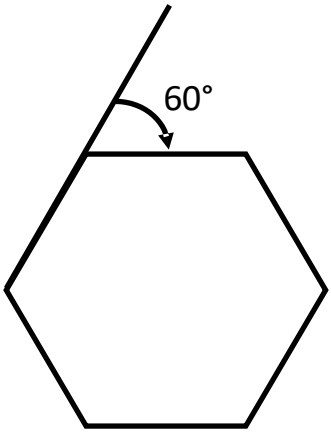


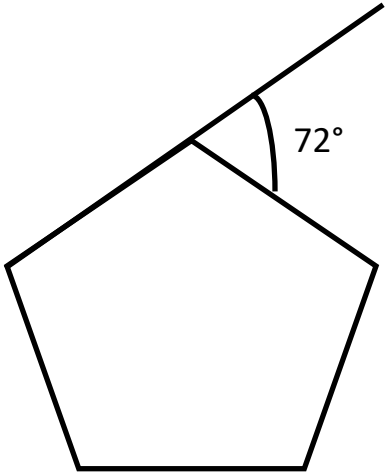


This is an example of an incomplete loop as 13 x 25 degrees does not equal 360 degrees.

Shape maths help

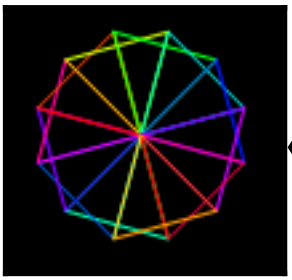
Teachers can provide a support card with the angles drawn in on multiple regular shapes to aid pupils algorithm and program creation and enforce the idea that we are using part of the outer angle NOT the inner angle.

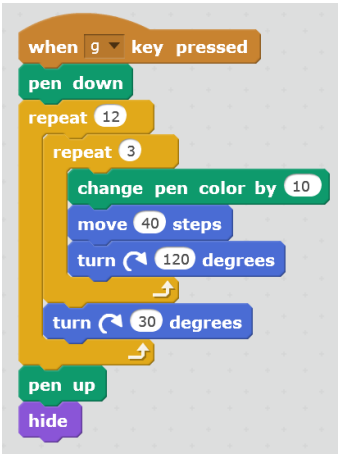


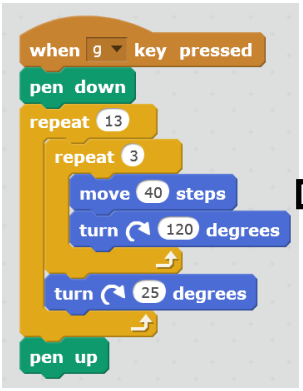


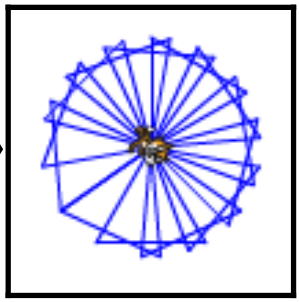
Firework challenge

Pupils are shown how a nested loop can be used to repeat a shape. They are instructed to create a firework pattern using nested loops and any other programming tools. The shape must create a complete pattern and not over draw. Overdrawing is where the pattern continues for more than 360 degrees.









This is an example of an incomplete loop as 13 x 25 degrees does not equal 360 degrees.

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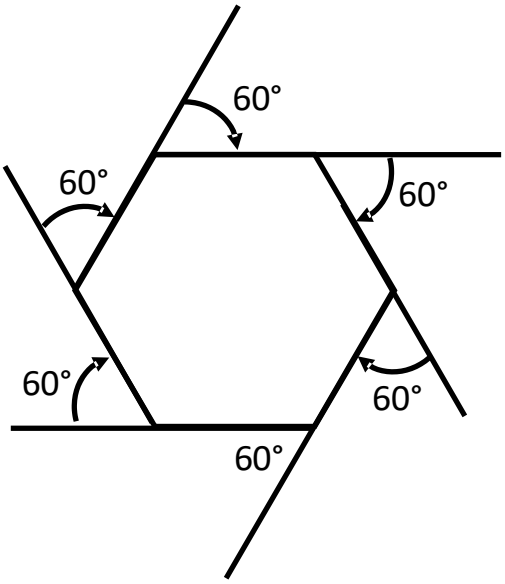
All outer angles add up to 360 degrees

Teachers can provide a support card with the angles drawn in on multiple regular shapes to aid pupils algorithm creation and enforce the idea that all the outer angles add up to 360 degrees.



60+60+60+60+60+60=360

60x6=360

Algorithmic elegance

Teachers are keen to draw out the increased elegance gained by using loops over sequence only algorithms.

A program that used 15 blocks of code now takes only 6.

It also makes it easier to adapt and use elsewhere when it contains less code as well as being easier to read.

6 blocks of code

15 blocks of code

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Promoting generalisation

Teachers are keen to promote the first steps towards generalsation. Adapting a solution that solved one problem to solve another.

When pupils come up with further ideas that they want to investigate this is to be encouraged especially if they can explain how they are going to use what they already know.

Pupils are more likely to value generalisation if a teacher has given them permission to think in these terms.

A useful stance may involve

Teaching about generalisation or what generalisation means.

Explaining that if pupils ask to adapt a project and can explain what they would start to investigate then teachers would do their best to find curricular time for this.

Reminding pupils that it is always a good idea to share their ideas on adapting projects with their teachers.

Stopping the class midway through a project and giving time for pupils to think what they would like to create from what they have learnt.

Giving a specific lesson over to pupils own adaptations after they have expressed ideas they would like to develop.

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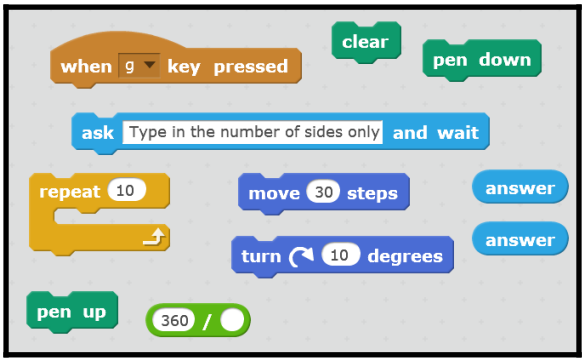
Multi shape extension challenge

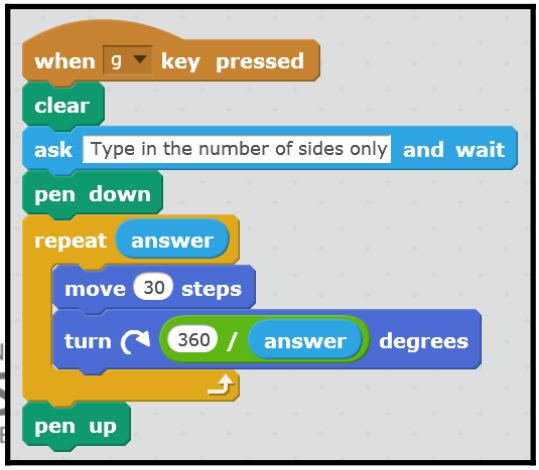
Teachers explain that it is possible to write a short program that will ask for the number of sides from the user and then use that information to calculate the angle and draw the shape.

Pupils will need to know that all the outer angles on a regular shape add up to 360 degrees.

Teachers could also give a limited amount of blocks scaffold if it is needed.

The scaffold and solution are below.





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A mistake in the algorithm

Teachers provide a sequence algorithm that is broken. They instruct pupils that their is at least one mistake in each algorithm. Can pupils discover what this is and fix it?

Stand in an empty space

Start drawing

Walk three step forwards

Turn right 120 degrees

Walk three step forwards

Turn right 120 degrees

Walk three step backwards

Turn right 120 degrees

Stop drawing

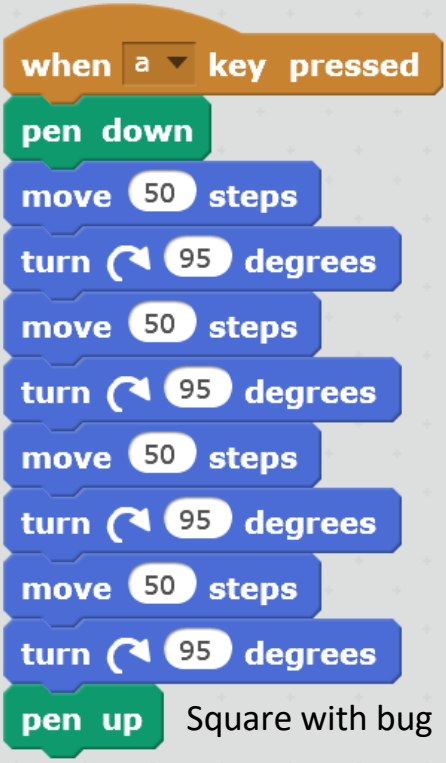
Triangle with error

This activity could be adapted for an algorithm with a loop or nested loop.

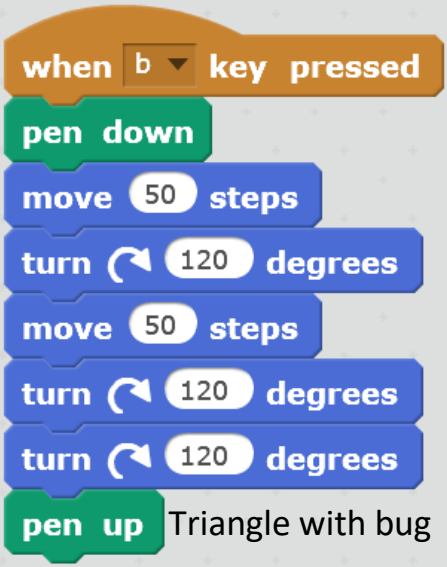
Broken code activity

Teachers provide sequence shape code that is broken. They instruct pupils that their is at least one bug in the code for every shape. Can pupils discover what this is and debug the code?

This can be a good activity to work with a partner.



Square with bug



Triangle with bug

This activity could be adapted for code with a loop or nested loop.

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Initialisation at the design level

Some Initilisation and operational issues in shape programming are

Thinking about where on the screen your shape will be drawn.

Whether the drawn shape will have enough space around it to complete successfully without the sprite bouncing off the edges?

If the sprite is ready to draw the shape again in exactly the same position if the program is executed again?

If the programme is executed again will the sprite draw over the top of the original drawing or if it will be cleared first.

Teach about the need to think about where the character will start on the screen and in which direction it will face in the design phase. Use the term initialisation to refer to this process and avoid using specific Scratch language.

Initialisation at the code level

Some Initilisation and operational issues in shape programming are

Thinking about where on the screen your shape will be drawn.

Whether the drawn shape will have enough space around it to complete successfully without the sprite bouncing off the edges?

If the sprite is ready to draw the shape again in exactly the same position if the program is executed again?

If the programme is executed again will the sprite draw over the top of the original drawing or if it will be cleared first.

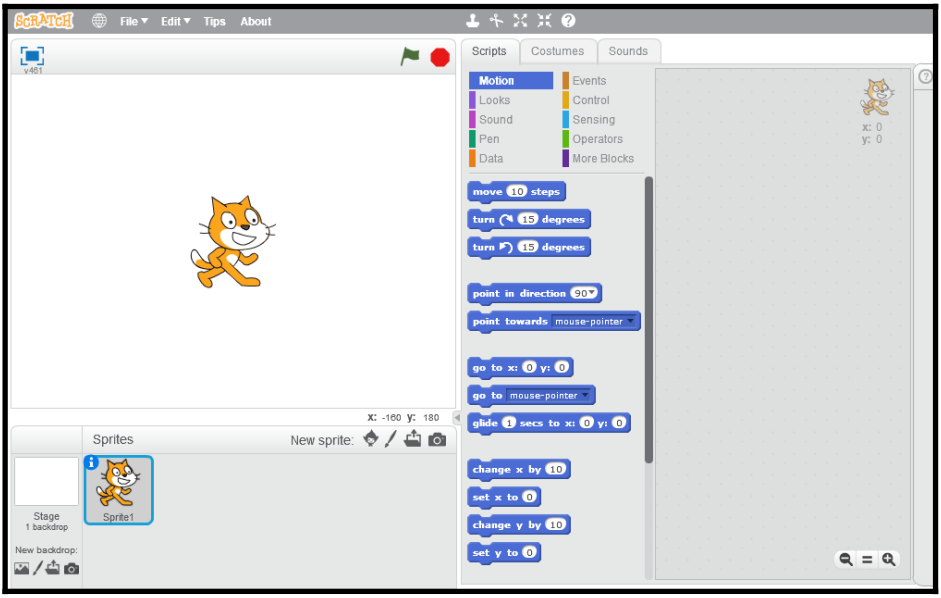
Teachers wait until pupils encounter one or more of these issues before teaching pupils about the importance of initialisation.

They may direct pupils back to their designs to decide where sprites will start and what direction they will face.

They may ask pupils to group source, through focussed tinkering, code solutions to the issues and report these back to the class.

Focussed Tinkering time

Teachers give pupils time to experiment around a specific theme. This might be shape sequences, shape repetition or drawing shapes using nested loops.



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