Micro:bit – Game with no rules

This activity involves using a BBC micro:bit and a game board with a 5x5 grid to explore concepts in Digital Technologies and Mathematics. Students first play a simple game, using a micro:bit to select how they move a counter on the game board. They record the numbers they land on to calculate a total score. Students then examine the results and draw conclusions based on the data collected.

The challenge activity has students develop their own maths-focused board games using the same resources, including designing an algorithm and a scoring system.

Curriculum links

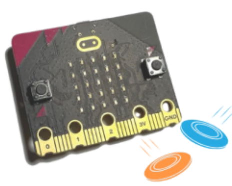
This activity and challenge are aligned with elements of the following learning areas. We encourage teachers to adapt the content and focus to suit the needs and interests of their students. They can be adapted for students between **Year 3 and Year 6**. More details are provided in the supporting documents.

Digital Technologies	Mathematics

Required resources

You will need the following materials:

- BBC micro:bit (one per group of students)
- USB cable and battery pack
- Laptop or tablet with Microsoft MakeCode editor and spreadsheet software
- Game board – see Supporting Documents
- Coloured counters.



12	8	2	17	6
16	5	9	20	13
11	21	1	18	23
19	14	25	7	3
4	22	10	24	15

Pre-requisite knowledge

Prior to this session, students should:

- have a basic knowledge of coding using block-based programming language
- understand how to download code to a micro:bit
- be aware that a micro:bit has multiple inputs and outputs – e.g. Buttons, Shake and LED options
- be able to carry out repeated trials of an experiment, record what happens, compare results, and talk about any differences they notice
- be able to conduct repeated chance experiments and observe relationships between outcomes
- be able to identify and describe differences between expected and observed results.

Supporting documents for these activities are available for download

https://universityofadelaide.box.com/v/microbit-game

Suggested steps

This activity could be delivered over a few sessions – depending on time available, the whole class introduction taking one 40-50 minute lesson and the challenge being conducted over a number of other sessions.

Whole class introduction

In small groups, provide each group with

- a 5x5 gameboard with numbers 1-25 (see supporting documents)
- a micro:bit
- a counter per player.

Students load the 'Sample MakeCode project – Simple arrows ' code onto the micro:bit which can be found in the supporting documents. This code will randomly display an arrow pointing N, S, E, W when button A is pressed.

Students play CSER example board game following these rules:

1. Players start with the counter in the middle square.
2. Press Button A on the micro:bit and move the counter according to the arrow that randomly displays.
3. Record the number the counter lands on. (either paper or spreadsheet)
4. Repeat 5 times and add the numbers.
5. If a player moves off the grid, the move scores zero points and the game ends.
6. The winner is the player with the highest score.

Each group should play the game at least 15 to 20 times and collect data. They create a spreadsheet (see sample below and sample documents) that includes the number of games and records the number landed on for each move and the total score for each game. They could also record the direction the arrow displays.

Each player will need to collect their data either using a table (see supporting documents) or by inputting the data directly into spreadsheet software. We have provided sample data for one player in the images below.

Game data record sheet

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	Game 1	Game 2	Game 3	Game 4	Game 5	Game 6	Game 7	Game 8	Game 9	Game 10	Game 11	Game 12	Game 13	Game 14	Game 15	Game 16	Game 17	Game 18	Game 19	Game 20
Move 1	9	21	21	18	18	25	18	18	25	9	21	9	9	9	18	18	18	18	18	25
Move 2	20	11	5	7	1	1	7	21	7	5	13	2	2	2	7	23	23	20	1	10
Move 3	9	21	16	25	9	9	24	5	24	21	25	17	17	8	25	0	18	9	25	25
Move 4	1	5	0	14	1	2	7	8	0	14	10	0	0	12	14	0	23	1	1	1
Move 5	7	9	0	25	25	17	18	12	0	21	24	0	0	0	22	0	18	21	21	9
Total Score	**46**	**67**	**42**	**89**	**54**	**54**	**74**	**64**	**56**	**70**	**93**	**28**	**28**	**31**	**86**	**41**	**100**	**69**	**66**	**70**

	Game 1	Game 2	Game 3	Game 4	Game 5	Game 6	Game 7	Game 8	Game 9	Game 10	Game 11	Game 12	Game 13	Game 14	Game 15	Game 16	Game 17	Game 18	Game 19	Game 20
Move 1	N	W	W	E	E	S	E	E	S	N	W	N	N	N	E	E	E	E	E	S
Move 2	E	W	N	S	W	N	S	W	E	W	S	N	N	N	S	E	E	N	W	S
Move 3	W	E	W	W	N	N	S	N	S	S	E	E	E	W	W	E	W	W	S	N
Move 4	S	N	W	W	S	N	N	N	S	S	S	N	N	W	W	W	E	S	N	N
Move 5	E	E	W	E	S	E	N	W	E	N	E	E	N	N	S	S	W	W	W	N

Referring to the data in the spreadsheet, both individual results and the combined class data, have students discuss variations in results, pose questions:

- What was the highest total score that was achieved in a game? What was the lowest?
- What is the maximum possible score that could be achieved? What is the minimum?
- What patterns do they notice?
- What are the chances that the counter will land on 25 in the first move?
- Did any game produce only odd or only even numbers?

In the image below, the raw data collected has been analysed and edited to indicate frequency of one player's moves for 20 games. Data from all players could be collated in a shared group spreadsheet for a larger data sample size.

	Game 1	Game 2	Game 3	Game 4	Game 5	Game 6	Game 7	Game 8	Game 9	Game 10	Game 11	Game 12	Game 13	Game 14	Game 15	Game 16	Game 17	Game 18	Game 19	Game 20
Move 1	9	21	21	18	18	25	18	18	25	9	21	9	9	9	18	18	18	18	18	25
Move 2	20	11	5	7	1	1	7	21	7	5	13	2	2	2	7	23	23	20	1	10
Move 3	9	21	16	25	9	9	24	5	24	21	25	17	17	8	25	0	18	9	25	25
Move 4	1	5	0	14	1	2	7	8	0	14	10	0	0	12	14	0	23	1	1	1
Move 5	7	9	0	25	25	17	18	12	0	21	24	0	0	0	22	0	18	21	21	9
Total Score	46	67	42	89	54	54	74	64	56	70	93	28	28	31	86	41	100	69	66	70

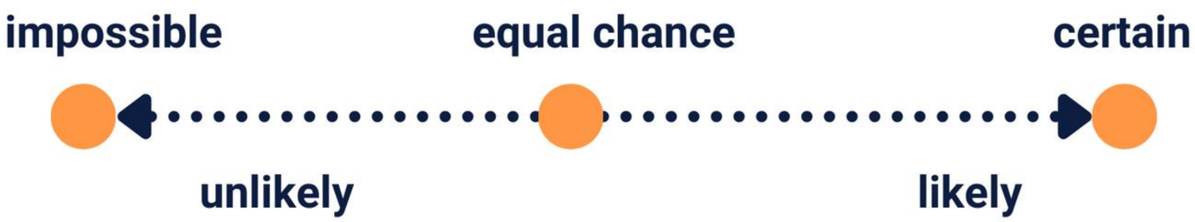
Number	Frequency	Number	Frequency	Number	Frequency	Number	Frequency	Number	Frequency
0	**12**								
1	**8**	6	**0**	11	**1**	16	**1**	21	**9**
2	**4**	7	**6**	12	**2**	17	**3**	22	**1**
3	**0**	8	**2**	13	**1**	18	**12**	23	**3**
4	**0**	9	**11**	14	**3**	19	**0**	24	**3**
5	**4**	10	**2**	15	**0**	20	**2**	25	**10**

Referring to the data in the spreadsheets, pose the following discussion questions. Note: We have also included some possible student responses.

- In how many games did the counter land on the same square more than once? 7 games, 1, 2, 4, 7, 21, 17, 20
- What are the possible scores for the first move? 9, 18, 21 or 25
- How likely is it that a player will reach the score of 150 in 5 moves? As the maximum score is 25 points, after five moves we can't score more than 125 points. In fact, we score less because we will move to squares with lower values. We could score 25 on the first move, but the next move could only be 1, 7, 10, 14.
- What are the possible scores for the second move? This depends on our first move. Starting on 9, our next move could be 1, 2, 5 or 20. Starting on 18, our next move could be 1, 7, 20 or 23.
- Does the data suggest that the first move was random/equally likely? In theory, each of the four directions (N, S, E, W) should be equally likely, meaning an equal chance of scoring 9, 18, 21 and 25 on the first move. In our 20 simulated games, 18 occurred 9 times out of 20, which is the result of chance variation.

- How often did the same direction appear twice in a row? E.g., W-W From the table, we're looking at two or more consecutive directions e.g., N-N or N-N-N
- What must happen in order to move off the board in three moves? We would need to move in the same directions.
- Did the same direction ever appear three times in a row? e.g., N-N-N Yes, several games (including Game 3 and 6) had three consecutive directions in a row.
- In how many games did the counter move off the board? We are looking for any games which contain a score of 0. This happened in 6 of the games (Games 3, 9, 12, 13, 14 and 16).
- Did some numbers appear more often than others? Yes, a look at the spreadsheet shows that some numbers occurred more than others.
- Did some numbers not appear at all? Yes, a look at the spreadsheet shows that some numbers did not occur at all (e.g., 3 and 4). If we played more games, these would eventually appear.
- Does this mean these numbers are impossible? It is possible for the counter to land on any of the squares of the grid. The nature of chance means that not all numbers will appear in any given game.
- Is it possible for a score to occur more than twice in a single game? Because there are a total of five moves, the same score could occur on the 1st move, 3rd move and 5th move (e.g., 18-1-18-1-18).

The following language regarding probability can be encouraged in the responses.



Challenge – Game with no rules

Using the knowledge and resources (5x5 grid with numbers 1-25, counters and a micro:bit) from the whole group activity, students are challenged with developing their own maths board game.

In small groups, students:

- choose which maths skills their game will focus on, such as addition, subtraction, multiplication, or division.
- determine what changes they will make to the current code or create their own.
- write an algorithm (pseudocode) to indicate the changes or the new code.
- decide on a scoring system and how a winner will be determined.
- create an algorithm (instructions) that explains the steps for playing their game. Note: we have provided some suggested code adaptions and rules in the support documents.

Each group plays their own game and checks that their instructions are clear, complete, and easy to follow. Once they have reviewed their game rules, have them swap with another group and provide feedback using a PMI framework.

- Plus: Positives, what did you like? What was done well?
- Minus: Negatives, what didn't you understand? What could have been improved?
- Interesting: Ideas that may need further investigation or any questions you may have.

Have students review and apply the feedback received to adapt their game instructions. Once updates are made, groups should play their game at least 10 times, recording results in a spreadsheet. Data should be collected to show whether all players have an equal chance of winning or if certain rules or strategies give an advantage. Data could also be used to identify patterns or trends.

Each group presents their final game to the class, explaining the maths skills it develops and how probability is used in its design. An expo could be held with other classes joining to play through the games.

Pose questions

Use these example questions to prompt student reflection, check for understanding, and encourage discussion to help students explain their thinking and build on each other's ideas.

- Which maths skills does your game use most? How do players practise them during the game?
- How did you decide on your scoring system and winning conditions?
- Did you make any rule changes during development? Why?
- What data did you collect, and how did you use this data in your game development?
- Do you think your game is fair? What evidence supports your answer?
- What patterns did you notice when you looked at your game's results?
- Did changes after feedback make your game more balanced or fun? How do you know?
- If you had more time, what would you change or add?

Why is this relevant? (Real world connections)

Designing and testing a maths board game helps us understand how probability, rules, and strategy affect outcomes. It's used in game design to balance fairness, in sports to plan winning tactics, and in business to make evidence-based decisions. Just like game developers and analysts, we can collect and analyse this data to improve performance, predict outcomes, and solve real-world problems, while connecting mathematics to creative, hands-on learning.

Assessment

Observation can be used to check students' ability to carry out tasks aligned to the Australian Curriculum. We have included some suggested questions for teachers to reflect on and to guide these observations.

Checking for understanding

- Were students able to describe/explain their algorithm and code, including iteration and branching?
- Were students able to debug and refine their code to ensure it matched their intended rules?
- Did students collect relevant data during gameplay and record it using tables or spreadsheets?
- Could they describe the possible outcomes of the game and explain the results of repeated trials?
- Could students discuss any differences between the expected and observed probabilities?

For more assessment resources we recommend the Assessment resources on the Digital Technologies Hub.

Teacher professional learning opportunities

We would like to thank the Australian Government Department of Education for funding our Lending Library and associated resource development.

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Supporting materials

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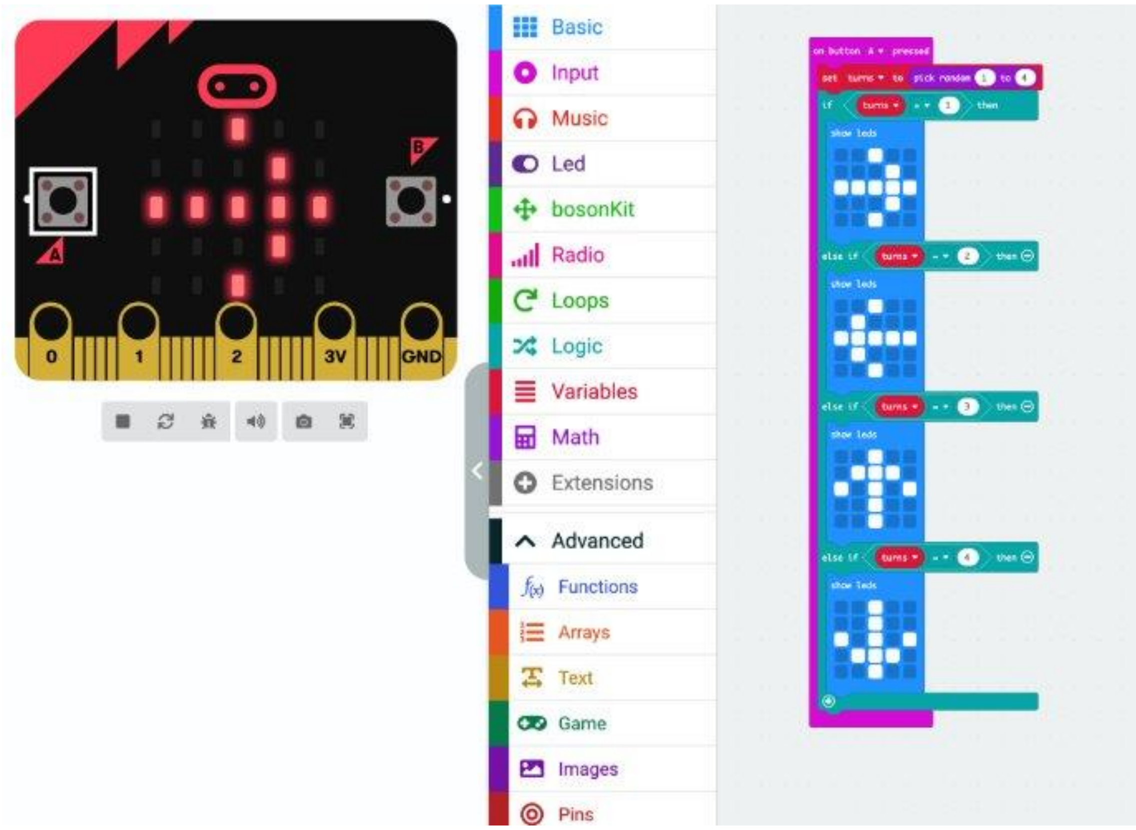
Sample game board for micro:bit activity - Game with no rules

Maths in Schools Professional Learning

CSER STEM PL csermoocs.adelaide.edu.au

Supporting documents including this game board and a blank board for the challenge are available for download https://universityofadelaide.box.com/v/microbit-game

Sample MakeCode project – Simple arrows



To access project: https://makecode.microbit.org/S85535-96896-07509-85074 - Click Edit and Download.

Then, connect your micro:bit to your computer using a USB cable. The micro:bit will appear as a USB drive on your computer. Finally, download the program file (a .hex file) and drag and drop it onto the micro:bit's drive.

Example variation to MakeCode and rules

When opening an existing MakeCode project, click 'Edit' and then you can make any changes to your copy of the project. You will need to login to MakeCode to save your changes.

MakeCode project	**Possible rules**
https://makecode.microbit.org/_Jikir2UcYbsv **This project features two inputs (Button A and Shake)** Input 1 – Button A Output – Random directional arrows (N, NE, S, SE etc) Input 2 – Shake Output – Generates a random number from 1-6	Each player starts at 0 Press Button A and move counter one space in that direction indicated. Shake micro:bit to determine the number to add (or subtract) from the number their counter is on.

Australian Curriculum

Depending on the challenges undertaken, these activities could be suitable for students between Year 3 and Year 6 Digital Technologies and Mathematics.

Digital Technologies

Students in Years 3 and 4 learn to:

- follow and describe algorithms involving sequencing, comparison operators (branching) and iteration (AC9TDI4P02)
- implement simple algorithms as visual programs involving control structures and input (AC9TDI4P04).

By the end of Year 4 students follow and describe simple algorithms involving branching and iteration and implement them as visual programs.

Students in Years 5 and 6 learn to:

- design algorithms involving multiple alternatives (branching) and iteration (AC9TDI6P02)
- implement algorithms as visual programs involving control structures, variables and input (AC9TDI6P05).

By the end of Year 6, students design algorithms involving complex branching and iteration and implement them as visual programs including variables.

Mathematics

Students in Year 3 learn to:

- acquire data for categorical and discrete numerical variables to address a question of interest or purpose by observing, collecting and accessing data sets; record the data using appropriate methods including frequency tables and spreadsheets (AC9M3ST01)
- conduct repeated chance experiments; identify and describe possible outcomes, record the results, recognise and discuss the variation (AC9M3P02).

By the end of Year 3 students record, represent and compare data they have collected. They use practical activities, observation or experiment to identify and describe outcomes explaining reasoning.

Students in Year 4 learn to:

- conduct statistical investigations, collecting data through survey responses and other methods; record and display data using digital tools; interpret the data and communicate the results (AC9M4ST03)
- conduct repeated chance experiments to observe relationships between outcomes; identify and describe the variation in results (AC9M4P02).

By the end of Year 4 students use digital tools to generate categorical or discrete numerical data in statistical investigations and communicate their findings in context. They conduct repeated chance experiments and describe the variation in results.

Students in Year 5 learn to:

- conduct repeated chance experiments including those with and without equally likely outcomes, observe and record the results; use frequency to compare outcomes and estimate their likelihoods (AC9M5P02).

By the end of Year 5 students conduct repeated chance experiments and make comparisons between those with and without equally likely outcomes.

Students in Years 6 learn to:

- conduct repeated chance experiments and run simulations with an increasing number of trials using digital tools; compare observations with expected results and discuss the effect on variation of increasing the number of trials (AC9M6P02).

By the end of Year 6 students conduct simulations using digital tools, to generate and record the outcomes from many trials of a chance experiment.