CODING WITH MINECRAFT 3: COORDINATES

Student workbook

education.minecraft.net

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OVERVIEW

Unit summary

This unit covers how to move around in a Minecraft world with respect to the three-coordinate grid represented by (X Y Z) coordinates and the difference between relative position and world position. You'll learn how to create a compass rose to help you find your way around and create a tool that allows you to copy and paste entire structures somewhere else in your Minecraft world!

Learning goals

By the end of this unit, you'll be able to:

- Describe the difference between relative coordinates and absolute coordinates in real life.
- Identify their real-world position and calculate the position of a landmark or object relative to their position.
- Describe the difference between relative player position and absolute world position in Minecraft.
- Understand the importance of coordinates in coding and while playing Minecraft.
- Alter the Minecraft landscape by coding with coordinates.
- Design an original creative project to apply their coding skills in new ways.

Coding concepts

Coordinates: Represent positions or locations, and tell a computer program where an action should take place by providing the location for the action.

Positions: Coordinates in MakeCode and Minecraft that identify a three-dimensional location in Minecraft as (X, Y, Z).

Types of coordinate positions

Absolute world	(X, Y, Z) represents the distance from the Minecraft world origin of (0, 0, 0). Fixed and does not change, no matter where the player currently is in Minecraft. The coordinates in the upper right of Minecraft show the current world position of the player.
Relative player	(~X, ~Y, ~Z) represents the distance from the player's current position as the origin of (~0, ~0, ~0). Not fixed and changes as the player moves around in Minecraft. Many MakeCode blocks code for actions relative to the player's current position.

LESSON A: INTRODUCTION TO COORDINATES

Overview: Coordinates

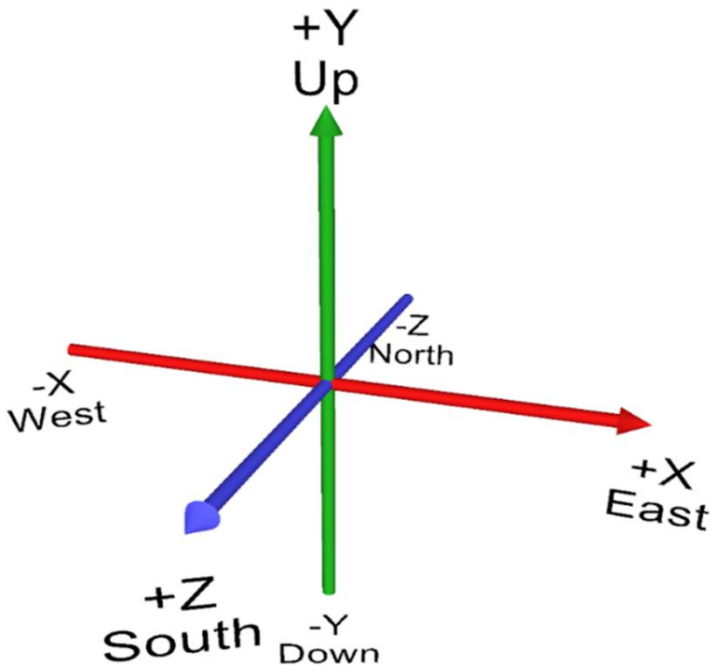
Why learn coordinates?

Minecraft uses a set of three coordinates (X, Y, and Z) to specify a position in a Minecraft world. MakeCode for Minecraft uses these coordinates in many of its blocks to specify where an action should take place.

Just as in a three-dimensional coordinate grid in math class, there is an origin point (0, 0, 0) where all three axes meet, and the coordinates X, Y, and Z represent distances from this point.

(X): The X coordinate represents a distance along the horizontal plane east or west of the origin, just like in real-world longitude values. You might also think of this as length.

- A distance east of the origin is represented by a positive X value, (+X).
- A distance west of the origin is represented by a negative X value, (-X).



(Y): The Y coordinate represents a distance along the vertical plane up or down from the origin, just like in real-world altitude values. You might also call this height.

- A distance up from the origin is represented by a positive Y value, (+Y).
- A distance down from the origin is represented by a negative Y value, (-Y).

(Z): The Z coordinate represents a distance north or south of the origin, just like in real-world latitude values. You might also think of this as width.

- A distance south of the origin is represented by a positive Z value, (+Z).
- A distance north of the origin is represented by a negative Z value, (-Z).

Tip: A quick and 'handy' way to remember the X, Y, and Z axes!

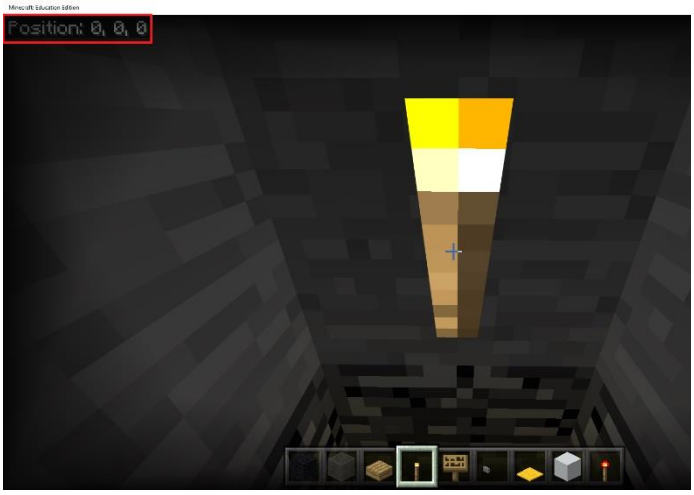
Hold your hand so you're pointing your index finger parallel to the ground as the X axis, your thumb straight up as the Y axis, and your middle finger perpendicular to your index finger as the Z axis.

Absolute world position versus relative player position

There are two different kinds of positions in Minecraft:

1. **Absolute world position** = A position that is based on position in the world (in other words, the distance from the world's origin point (0, 0, 0) to an object or entity).

- Could be far down in the ground
- Is visible in the game if you press F1



In this example, your world position in this Minecraft world is currently (3, 98, 0). These numbers represent how far away you are from the world origin point (0, 0, 0).

- **X = 3** means that you are three blocks east of the origin point.
- **Y = 98** means that you are 98 blocks above the origin point.
- **Z = 0** means that you are at the north-south origin.

Tip: To see where you are in Minecraft, press the function key F1. Your world position (X, Y, Z) coordinates will appear in the upper-left corner of your Minecraft window.

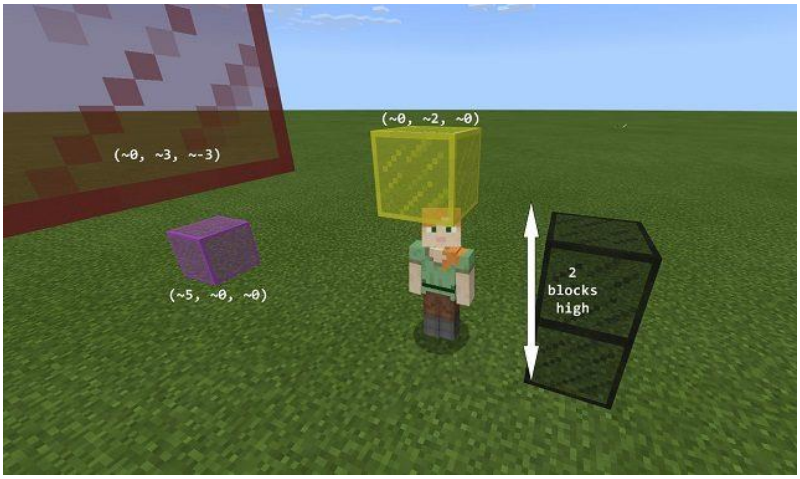
Now you try!

- Walk around in Minecraft and see how these values change.
- Press the spacebar to jump and notice that your altitude (the Y value) changes momentarily by +1.
- If you are flying, Y will change a lot.

2. **Relative player position** = A position that is based on where the player is (in other words, the distance from the player to an object or entity). Relative positions are denoted by a ~ (tilde) symbol before each of the three numbers that make up the three-coordinate (~X, ~Y, ~Z) position.

- Distance from the player to an object or entity
- Not visible in game

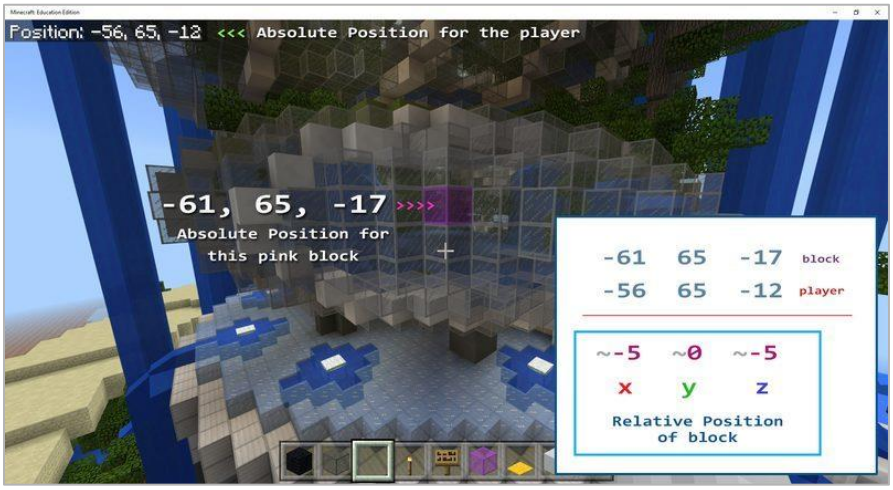
Minecraft players are two blocks tall, so (~0, ~0, ~0) represents the player's feet and (~0 ~1 ~0) represents the player's head. As a player moves around in Minecraft, so do the player's feet, which means the relative position is NOT a fixed position – it changes as the player moves around in the game.



For example, wherever the player is in the Minecraft world:

- (~0, ~2, ~0) will always represent the location just above the player's head.
- (~5, ~0, ~0) will always represent the location five blocks east of the player's current position.
- (~0, ~3, ~-3) will always represent the block two blocks above the player's head and three blocks north of the player's current position.

Here the block is five blocks west and five blocks north of the character. Both the player and the block are at the same height (65) or level of the Y axis.



Today's activities

- Play an unplugged activity to get familiar with coordinates
- Code with coordinates: Create a compass rose

Unplugged activity: World landmarks

In this activity, you'll get familiar with the difference between relative coordinates and absolute coordinates.

Real-life examples

On Earth, the latitude at the equator is 0°, and at the North Pole it is 90° north. A degree of latitude covers about 70 miles or about 112 kilometers.

The earth's geographical origin point, called Null Island, is marked by a weather buoy off the coast of Africa that's moored at coordinates 0°N 0°E.

Mount Everest has world coordinates of 27° north and 86° east of the origin point or 27°N 86°E.

The Empire State Building has world coordinates of 40° north and 73° west of the origin point or 40°N -73°E.

Our world position and relative positions

1. Find your own real-world position - the latitude and longitude of where you are right now.

2. Choose a world landmark and look up the landmark's real-world position - its latitude and longitude.

3. Calculate the position of the landmark relative to your current location. Subtract the latitude and longitude of the landmark from your real-world position.

Coding activity: Create a compass rose

In this activity, you'll use using coordinates to create a simple *compass rose* that points to the four cardinal directions within a Minecraft world.

Import the tutorial to MakeCode from here:
https://minecraft.makecode.com/?ipc=1#tutorial:github:mojang/educationcontent/CodingWithMinecraft/unit_3/lesson_A

Run the code in Minecraft

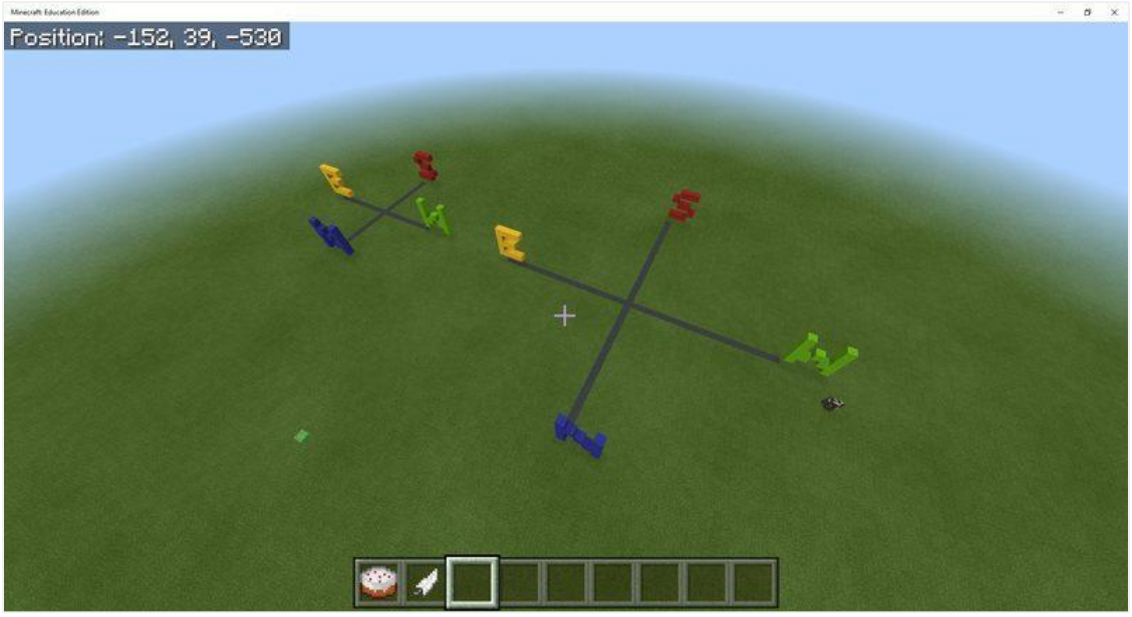
Go into a Flat World in Minecraft and enter **compassrose** in the chat command line. For best results, have your player stand still while the letters are being drawn – remember, the positions are being calculated relative to you as the player, so if you move around, the letters will show up in different places!

Challenges

Now you can change some things to make your own different and unique situations!

Challenge 1 – Create a bigger compass

Extend the axis of your compass rose to 41 blocks long. Can you get the letters to print nicely on the end of this new, bigger compass rose?

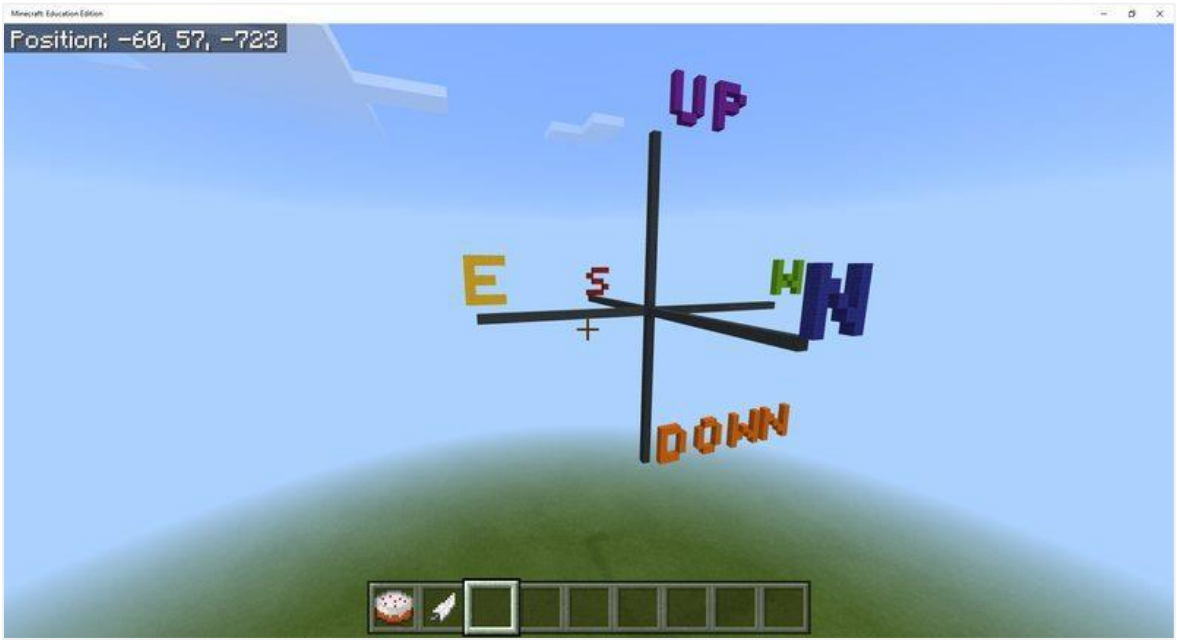


Challenge 2 - Build an Air Compass

Add an up-and-down **Y**-axis and labels. Make your compass up in the sky, so you can look up and see it as you walk along. What you will need to do:

1. First, you need to move the regular compass into the sky. What coordinate (X, Y, or Z) would you change?
1. Next, you need to build an axis for **Y**. How could you copy existing code, change it a little, and accomplish that?
2. Finally, print out the words “up” and “down.”

Tip: When you print out the words “up” and “down,” move them a little forward (north/south) and a little sideways (east/west). If you don’t, the words might cut into your Y-axis.



Write your ideas here:

Extensions

Here there are no rules... Copy the code and change things around to see what kind of results you can create. Suggestions are given but do as you like!

Extension 1 - Use Color for Directions

Instead of using **Gray Wool** to print out a line of blocks along the **X**, **Y**, and **Z** axes, you can select different colors to represent the three different directions.

What else might you add to make this more entertaining? What if chickens appeared after blocks? Chickens running along the east/west axis might be interesting. Could you somehow make arrows instead of just straight lines?

Extension 2 - Use Colors to Represent Other Compass Features

How about changing the colors of the printed text to the colors of the **X**, **Y**, and **Z** axes? You could change all the colors to something else. You could theme this out a little - make the compass in wood and then use stone and other items to give this compass a medieval theme. How would you theme it?

What if instead of creating a theme you change the code so the **Y**-axis goes up all the way from the ground like a tower?

Write your ideas here:

LESSON B: CODING WITH COORDINATES

Today's activities

- Turn our classroom into a Minecraft world for an unplugged activity: Classroom coordinates
- Use coordinates to code a tool to copy and paste structures somewhere else in Minecraft

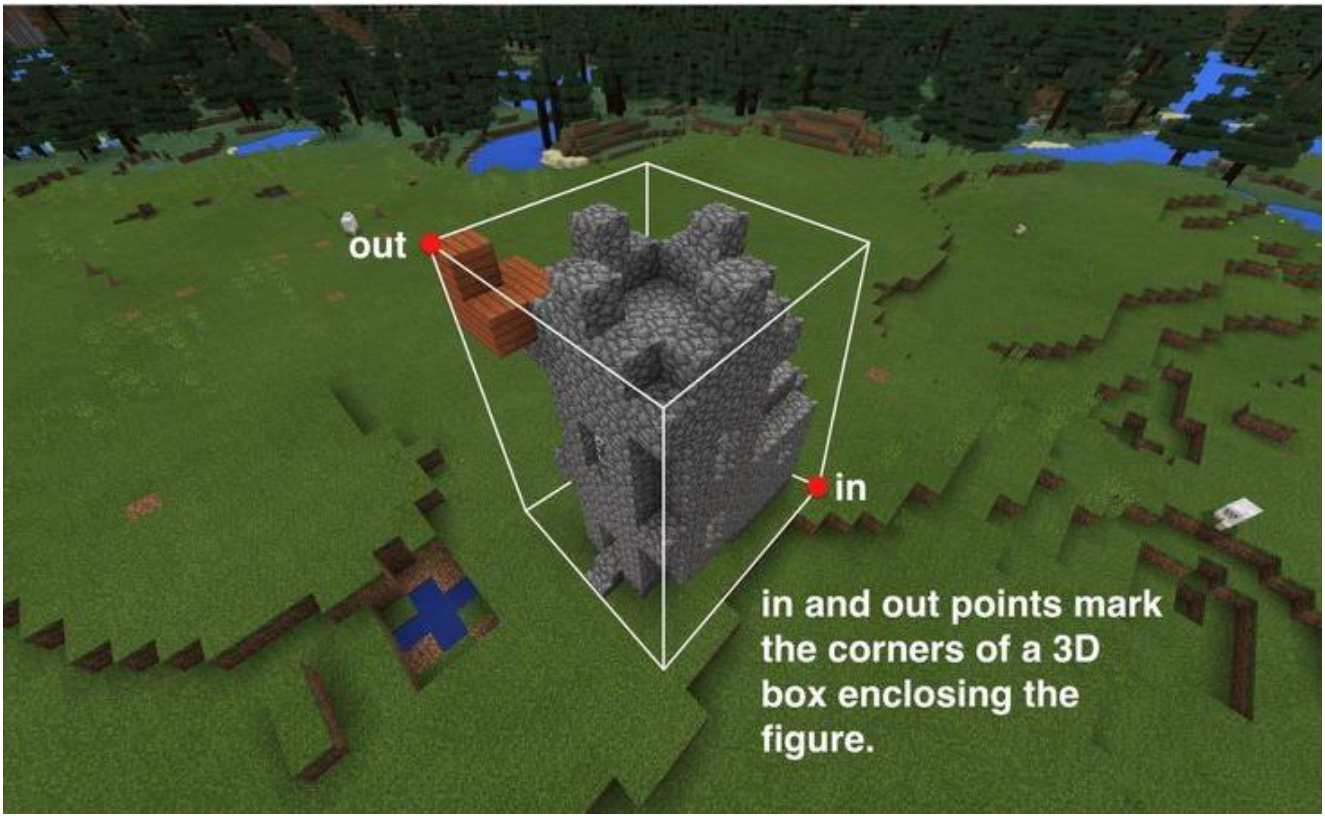
Coding activity: Minecraft Moving Company

If you've ever built the perfect house in Minecraft but wished you had done it in a different location, now you can! You can use coordinates and some of the block operations in the BLOCKS Toolbox drawer to copy and paste entire portions of the Minecraft landscape. You can copy hillsides, lakes, and even entire buildings! Let's create a way to specify an area of the world, then copy it somewhere else.

In this project, you'll use three different on chat command commands:

- `"start"` : This sets one corner of the area to be copied.
- `"stop"` : This sets the opposite corner of the area to be copied.
- `"copy"` : This creates an exact copy of everything between the start and stop points, placing it at your current position.

Import the tutorial to MakeCode from here:
https://minecraft.makecode.com/?ipc=1#tutorial:github:mojang/educationcontent/CodingWithMinecraft/unit_3/lesson_B



1. Enter into a Minecraft world where you have a house or some other structure you want to copy.
2. Move your player to one of the bottom corners of the structure, and in the chat window, type the command **start.**
3. Move your player diagonally to the top corner from the start. In the chat window, type the command **stop.**
4. Move your player to an open space in the world where you want to copy the structure, and in the chat window, type the command **copy**.

Did it copy your house or structure correctly?

Tip: If you can, leave a block or two of space between your character and the object you are copying. That way you will not cut it off.

For fun, cut some objects in half!!

The orientation of whatever you copy will always be the same. For example, if a building faces east, it is always going to face east.

In the clone block, for the **mode** property, if you choose move instead of normal, the code will perform a cut and paste rather than a copy and paste. It will delete what was in between the old coordinates and paste a copy at the new coordinates.

Challenges

Now you can change some things to make your own different and unique situations!

Challenge 1 - Cut and Paste Structures

How would you move something instead of copying it? Play around with the settings of the clone block to make this possible. Then rename your on chat command to `"cut_paste"`.

Challenge 2 - Move Only the Tree Trunk

How would you implement a cut and paste special? Is there a way to cut only certain blocks from an area?

Let's try to cut only the trunk from a tree.

Can any of the settings in clone help you? See if you can figure out how!

Hint: Did you notice that there are two kinds of clone blocks?

Write your ideas here:

LESSON C: CODE WITH COORDINATES AND MOVING OBJECTS

Today's activities

- Herd sheep in Minecraft
- Take a quiz

Coding activity: Auto-farmer

In this activity, you'll become a *farmer* who herds sheep in Minecraft, but of course you'll use a bit of code to make it happen! Let's create some sheep and then *auto* matically put them in their pen.

Import the tutorial into MakeCode from here:
https://minecraft.makecode.com/?ipc=1#tutorial:github:mojang/educationcontent/CodingWithMinecraft/unit_3/lesson_C

Challenges

Now you can change some things to make your own different and unique situations!

Challenge 1 - Spawn Some Polar Bears Randomly

In this challenge, test out a new protection system for your player. First, you'll need some animals to test it out. Spawn some polar bears randomly, but make sure to put them a little bit away from your player so you can get ready. You can use the on walk event or something else if you prefer.

> Do you remember how to use random positions?

Challenge 2 - Build a Protective Cage

Now, instead of building a pen to keep the bears in, you will build a cage to keep your player safe. It should be five blocks square around your player and five blocks tall. You can use the on sneak event and any fencing you like.

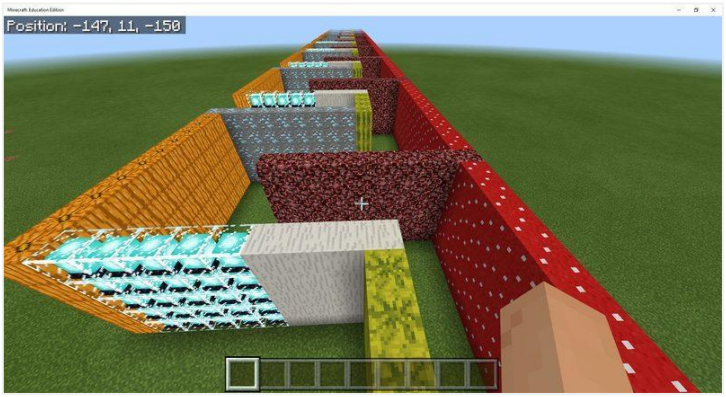
> To sneak, hold down **Shift** while pressing **W** key.
>
> Next you will need to set the gamemode to Survival to make this interesting. Enter this in the chat window: `/gamemode s`
>
> Finally, make sure your difficulty is not set to Peaceful. Enter this in the chat window: `/difficulty n`

Extension 1 Mazebuilder

Here there are no rules… Copy the code and change things around to see what kind of results you can create. Suggestions are given, but do as you like!

This is a maze builder. First, enter **ms** in the chat window and then sprint by holding down the **Control** key and pressing **W**.

A maze should build as you run. You could change the colors or extension with the shapes to make your own maze. What can you create?



LESSON D: GET CREATIVE WITH COORDINATES

Today's activities

- Design your coding project
- Complete and turn in your Minecraft diary entry

Coding activity: Independent project

For your independent project, create one or more commands that alter the landscape in some way. Here are some ideas:

- In a set area, replace all blocks of a certain type with something new (for example, replace all grass with lava).
- Create an "instant swimming pool" filled with water or… lava!
- Create a way to instantly tunnel through a mountain or portions of the nether.
- Create a way to literally "move mountains."
- Make a rainbow.
- Improve the Minecraft Moving Company activity so that you can enter a height for the upper coordinate rather than having to actually stand there yourself.
- Experiment with the **Mask** and **Mode** menus on the clone block.

Project expectations

Your project should do the following:

- Use coordinates in some way
- Alter the landscape by using code
- Be creative and original

Project examples

This project allows you to create a section of paved road with streetlights.

Duplicate this section numerous times to create a new street of any length.

Minecraft Diary

Compose a diary entry addressing the following:

- How did you come up with this idea? What problem are you trying to solve and why?
- What did you decide to alter in the landscape?
- What does your program do?
- Describe how your program alters the landscape.
- Include at least one screenshot of the result of your program.

Note: If you decided to improve one of this unit's coding activities, please talk about the new code you wrote in addition to what was already provided in the lesson.

Grading criteria

Assessment	1	2	3	4
Project	Project lacks all three of the required elements.	Project lacks two out of the three required elements.	Project lacks one out of the three required elements.	Project alters the landscape in a creative and original way, efficiently and effectively using coordinates.
Diary	Minecraft diary entry is missing four or more of the required prompts.	Minecraft diary entry is missing two or three of the required prompts.	Minecraft diary entry is missing one of the required prompts.	Minecraft diary addresses all prompts.

Write your ideas here:

GLOSSARY OF KEY TERMS

Absolute world position: A position of (X, Y, Z) coordinates that represents the distance from the Minecraft world origin of (0, 0, 0).

Compass rose: A figure on a compass, map, nautical chart, or monument used to display the orientation of the cardinal directions: north, east, south, and west—and their intermediate points. Also known as a wind rose or Rose of the Winds.

Coordinates: Represent positions or locations, and tell a computer program where an action should take place by providing the location for the action.

Positions: Coordinates in MakeCode and Minecraft that identify a three-dimensional location in Minecraft as (X, Y, Z).

Relative player position: A position of (~X, ~Y, ~Z) coordinates that represents the distance from the player's current position as the origin of (~0, ~0, ~0).