



Teaching Sheet Lesson 1

Aims and Objectives

Lesson 1 of the Beginner's Guide aims to give participants the fundamental knowledge and background they need to complete the rest of the course. By the end of the lesson, participants should be able to:

- Name the different parts of the Grove board and give examples of how they might be used.
- Describe the basic concepts of a microcontroller.
- Describe the steps involved in programming the Arduino board and how information is transmitted in this system.
- Name three of the most common types of electronic communication and explain the difference between them.
- List the pin (port) connections for each of the board's components.
- Recall the different parts of the XOD IDE software and describe what each part is used for.
- Recount the three key terms used in XOD programming and what they mean.
- List the data types used in XOD and give examples of each.

Key Points to Cover

Use the powerpoint presentation provided as a base for the content in this lesson. You may want to add or remove certain slides or content from this presentation depending on your audience.

THE STARTER KIT

- Introduce the Grove board, including a brief explanation of what each of the modules does.

THE MICROCONTROLLER

- Give a simple explanation of about what a microcontroller is and how it works.
- Introduce the concept of different communication types (analog, digital, I2C).
- Give an overview of the process of programming the Arduino board.

THE XOD IDE

- Introduce the XOD IDE, including a brief explanation of each of the panes and useful buttons.
- Introduce the XOD concepts of nodes, pins and links.
- Give an overview of the different XOD data types.

Teaching Sheet Lesson 2



Aims and Objectives

Lesson 2 of the Beginner's Guide aims to get participants comfortable with using the XOD software to programme their boards using two examples of simple programmes. By the end of the lesson, participants should be able to:

- Prepare the Biomaker starter kit by downloading the relevant software and drivers, plugging in your board, and opening the XOD IDE.
- Name the different sections of the XOD IDE and understand what they are used for.
- Apply their knowledge of the XOD IDE to perform the following simple tasks: add a node, change pin settings, connect nodes, add a library.
- Use the XOD IDE to upload programmes to your board.
- Use the XOD IDE to clear programmes from your board.
- Use three of the inbuilt components on the Grove board: the LED, the buzzer and the button.
- Understand how to troubleshoot your programme and find additional help.
- Understand how input and output devices can be used together to build simple devices.

Key Points to Cover

Use the powerpoint presentation provided as a base for the content in this lesson. You may want to add or remove certain slides or content from this presentation depending on your audience. You can either 1) demonstrate both tasks at once with participants trying both tasks at the end, or 2) demonstrate each task in turn with participants practicing after each demonstration. For online workshops we suggest option 1, for in person workshops we suggest option 2. When demonstrating, try to show both how you build the programme on your computer screen, using a projector or share screen, and what happens to your board when you upload, via a physical demonstration or a video.

TESTING YOUR BOARD

- Demonstrate Task 1. This will demonstrate much of what they have just learned in Lesson 1.
- Task 1 uses the *led*, *button* and *not* nodes to control the onboard LED using the button.

INPUTS AND OUTPUTS

- Demonstrate Task 2, which replaces the LED with a buzzer, and adds a potentiometer to control the pitch.

Teaching Sheet Lesson 3

Aims and Objectives

Lesson 3 of the Beginner's Guide aims to demonstrate the use of some of the most useful nodes in XOD. These nodes will be used often in the following chapters, and it is good to have an understanding of how they work before proceeding. By the end of the lesson, participants should be able to:

- Explain the functions of the following XOD nodes: *tweak*, *watch*, *flip-n-times*, *flip-flop*, *clock*, *count*, *concat*, *join*, *format-number*.
- Apply their knowledge of these nodes to start building simple programmes.
- Use the XOD IDE to create and save a new project.
- Use the XOD IDE to 'upload and debug' programmes, allowing you to watch and edit their programme live.
- Use two more of the inbuilt components on the Grove board: the temperature and humidity sensor and the air pressure sensor.
- Build and compare different versions of a programme to achieve different functions and outcomes.
- Experiment with the programmes they have built by changing parameters and exploring new nodes
- Understand where to find more information about the basic nodes available in XOD



Key Points to Cover

We suggest running through the tasks in Lesson 3 by simply demonstrating each task. The powerpoint slides include a title slide to go over the basics for each set of nodes, and a video slide with a demonstration of the task.

TWEAK AND WATCH NODES

- *tweak* and *watch* nodes are used alongside the XOD 'Debugger' to edit and watch programmes in real-time.
- They are useful for trouble shooting and checking that programmes are running correctly.
- Task 3 uses a *tweak* node to initiate readings from the temperature and humidity sensor, and *watch* nodes to view the results.

FLIP, CLOCK AND COUNT NODES

- These nodes are useful for controlling and monitoring the timing of you programme.
- Task 4 demonstrates how the *flip-n-times*, *flip-flop* and *clock* nodes can be used to control the LED in different ways, and how the *count* and *watch* nodes can be used monitor the programmes progress.

CONCAT, JOIN AND FORMAT NUMBER

- These nodes are useful for formatting text and number outputs from programmes.
- Task 5 demonstrates how to use these nodes to format the outputs from the air-pressure sensor.

Teaching Sheet Lesson 4

Aims and Objectives

Lesson 4 of the Beginner's Guide aims to give participants the skills they need to start building more complex programmes in XOD. These skills should set participants up to start thinking about how to make their own programmes and devices. By the end of the lesson, participants should be able to:

- Describe the function of XOD terminal nodes and how they are used.
- Create new nodes in XOD by combining existing and terminal nodes.
- Test and use the new nodes you have created in programmes.
- Describe the function of buses, their advantages, and how to use them.
- Use maths and logic nodes to create logic programmes in XOD.
- Recall at least two different methods for creating sequences in XOD.
- Implement programming loops in XOD using the *defer* node.
- Use the remaining components on the Grove board: the sound sensor, light sensor, 3-axis acceleration sensor and the OLED screen.
- Programme the OLED screen to display graphics such as text and shapes.
- Recall how to document your nodes correctly, including describing the node and it's pins and adding comment boxes.
- Recall how to publish nodes, or collections of patches a library.

Key Points to Cover

You can use the powerpoint presentation provided as a base to demonstrate and practice each task in turn.

CREATING NEW NODES

- Programmes can be simplified by encapsulating sections into new nodes using *input* and *output* terminals.
- In Task 6 participants create a new node to write text on the OLED screen.

USING BUSES

- Buses link different parts of the programme 'invisibly' and are useful for tidying up complex programmes.
- Task 7 demonstrates how buses work by creating a game using the 3-axis acceleration sensor and screen.
- If you are short on time, you can modify the node created in Task 6 to demonstrate the use of buses instead.

LOGIC PROGRAMMES

- You can use logic nodes like IF, OR, AND, to create logic programmes that covert inputs to outputs.
- Task 8 uses logic nodes to return different text on the screen depending on the surrounding light intensity.

SEQUENCES AND LOOPS

- There are a many ways to create sequences in XOD, and Task 9 demonstrates two of these.
- Task 9 also demonstrates how to create loops using the *defer* node to play a simple tune on the buzzer.



Teaching Sheet Lesson 5

Aims and Objectives

Lesson 5 of the Beginner's Guide aims to equip participants with the knowledge of where to go next, how to start adding hardware to their boards, and where to find help and advice for their own projects. By the end of the lesson, participants should be able to:

- Recall where to find additional components compatible with the Grove board.
- Recognise the different ways to connect new components to the Grove board.
- Locate compatible XOD nodes for new devices.
- Outline some examples of how these skills can be applied to biological research.
- Recall where to find additional information and help with building their own devices.

Key Points to Cover

You can use the powerpoint presentation provided as a base for the content in this lesson.

EXPANDING YOUR CAPACITY

- There are a wide variety of components that can be added to the board to create custom devices.
- There are 'plug-and-play' components and components you need to wire, the slides and the guide provide information on how to attach different types of component to the board and where to buy them from.
- You can find nodes for many devices on the XOD website and forum, or convert Arduino libraries to XOD.
- The Arduino IDE can be a useful tool for taking your skills further

CASE STUDIES

- The guide contains four case studies of custom devices used for biological research.
- Initiate a discussion around the case studies as a basis for encouraging participants to think about what devices might be useful for their own research.
- If you have time, encourage participants to start planning their own devices and think about what hardware and programming skills they might need to achieve that.

