QADiR CORPORATION ROBOTICS

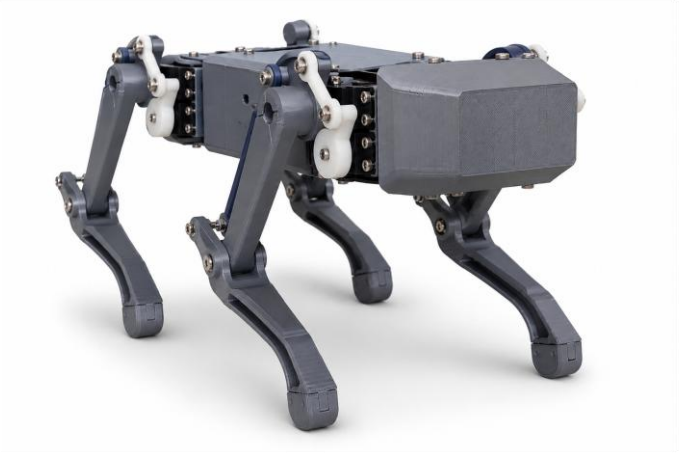
EDU Mini

Quadruped Robot Student Hands-On Workbook

28 Complete Lessons | 50 Minutes Each

DIY Kit • Ready Kit

ESP32 / MicroPython



Version V5.5 | Student Edition

QADIR Corporation

www.qadircorp.com

Contents / Index

Scope and Important Notes 4

Course Outline 5

Lesson 01 | Getting to Know EDU Mini, Learning Objectives, and Operational Safety 6

Lesson 02 | Identifying Parts, Tools, and Assembly Preparation 8

Lesson 03 | DIY Leg Assembly (Part 1) / Ready Kit Structural Observation 10

Lesson 04 | DIY Leg Assembly (Part 2) / Ready Kit Mechanism Analysis 12

Lesson 05 | Installing the Four Legs and Identifying Orientation 14

Lesson 06 | Mechanical Inspection and Assembly Acceptance 16

Lesson 07 | EDU Mini Servos, Joints, and 12 DOF 19

Lesson 08 | ESP32, Power, and Signal Systems 21

Lesson 09 | First Power-On and Safety Checks 23

Lesson 10 | Mobile App Operation and Motion Observation 25

Lesson 11 | Installing Thonny, USB Connection, and Serial Ports 28

Lesson 12 | Flashing MicroPython Firmware and Verifying the Version 30

Lesson 13 | Your First Program: Running, Saving, and Uploading 32

Contents / Index (continued)

Lesson 14 | Python Basics (1): Output, Variables, and Types 34
Lesson 15 | Python Basics (2): Operators and Conditional Logic 36
Lesson 16 | Python Basics (3): Loops and Timing 38
Lesson 17 | Python Basics (4): Functions and Parameters 40
Lesson 18 | Python Basics (5): Lists and Dictionaries 42
Lesson 19 | Modular Programming, Exception Handling, and Debugging 44
Lesson 20 | Joint Angles, Control Interfaces, and Safety Limits 46
Lesson 21 | Posture, Center of Gravity, and Standing Stability 48
Lesson 22 | Gait Principles and Parameters 50
Lesson 23 | Forward, Backward, and Turning Motions 52
Lesson 24 | Motion Sequences and Data Logging 54
Lesson 25 | Basic Kinematics and Motion Improvement 56
Lesson 26 | Project Design and Experimental Planning 58
Lesson 27 | Project Implementation and Testing 60
Lesson 28 | Project Presentation, Assessment, and Reflection 62

QADIR EDU Mini

Student Hands-On Workbook | 28 × 50-Minute Lessons | V5.5 English Edition (Proofread)

ESP32 / MicroPython | High School, Vocational College, and University | For Both DIY Kit and Ready Kit

Learning sequence: Assemble the robot, operate it, learn to program the ESP32, understand Python, and complete a quadruped robotics project.

Scope and Important Notes

This edition brings together 28 lessons, illustrated assembly instructions, Python practice examples, and student worksheets. Model-specific procedures must be confirmed by QADIR Engineering. Video screenshots may be used as visual assembly aids, but actual assembly orientation, factory calibration, firmware version, wiring, control APIs, and safe motion limits must be verified against QADIR production engineering documentation. Unverified robot commands are not presented as executable official instructions.

DIY Kit: Full assembly required. Ready Kit: Main body is preassembled; students install the four legs. Both use the standard twelve EDU Mini Servos and an ESP32. The EDU Mini Servo-PWM is an optional retrofit accessory sold separately.

ℹ Factory Settings | Servo Angles Are Factory-Calibrated

[Factory Calibration] The EDU Mini servos are angle-calibrated before shipment. Students do not need to adjust their servo zero positions during assembly. Follow the assembly illustrations. Do not forcibly rotate the joints or change calibration parameters, as this may damage the mechanism or cause abnormal operation.

Flashing firmware (installing the MicroPython runtime) and uploading Python programs (writing .py files) are different operations. Firmware flashing on a physical robot requires approval from the instructor or QADIR to avoid overwriting the factory control software.

Course Outline

Lesson	Topic
01	Getting to Know EDU Mini, Learning Objectives, and Operational Safety
02	Identifying Parts, Tools, and Assembly Preparation
03	DIY Leg Assembly (Part 1) / Ready Kit Structural Observation
04	DIY Leg Assembly (Part 2) / Ready Kit Mechanism Analysis
05	Installing the Four Legs and Identifying Orientation
06	Mechanical Inspection and Assembly Acceptance
07	EDU Mini Servos, Joints, and 12 DOF
08	ESP32, Power, and Signal Systems
09	First Power-On and Safety Checks
10	Mobile App Operation and Motion Observation
11	Installing Thonny, USB Connection, and Serial Ports
12	Flashing MicroPython Firmware and Verifying the Version
13	Your First Program: Running, Saving, and Uploading
14	Python Basics (1): Output, Variables, and Types
15	Python Basics (2): Operators and Conditional Logic
16	Python Basics (3): Loops and Timing
17	Python Basics (4): Functions and Parameters
18	Python Basics (5): Lists and Dictionaries
19	Modular Programming, Exception Handling, and Debugging
20	Joint Angles, Control Interfaces, and Safety Limits
21	Posture, Center of Gravity, and Standing Stability
22	Gait Principles and Parameters
23	Forward, Backward, and Turning Motions

24	Motion Sequences and Data Logging
25	Basic Kinematics and Motion Improvement
26	Project Design and Experimental Planning
27	Project Implementation and Testing
28	Project Presentation, Assessment, and Reflection

Lesson 01 | Getting to Know EDU Mini, Learning Objectives, and Operational Safety

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Explain the quadruped platform and differences between DIY and Ready kits

Lesson Plan (50 minutes)

0–8 min | Introduction, safety check, and lesson objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Identify risks from batteries, pinch points, unexpected startup, and falls from a table; draw a safe work area.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Identify risks from batteries, pinch points, unexpected startup, and falls from a table; draw a safe work area.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 1.

Lesson 02 | Identifying Parts, Tools, and Assembly Preparation

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Identify components and use assembly tools

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Use a parts inventory checklist to count components in groups; label left/right, front/rear, screws, and linkages; take photos as evidence.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Use a parts inventory checklist to count components in groups; label left/right, front/rear, screws, and linkages; take photos as evidence.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 2.

⚠ Assembly Safety | Read Before Proceeding

Assembly Safety Reminder | Tightening Screws

Do not overtighten screws. Tighten only enough to secure parts without looseness. Overtightening can strip threads or crack or chip plastic components. Use a correctly sized tool, align each screw with its hole, and stop to inspect if you feel unusual resistance. Never force a screw into place.

After assembly, check that all fasteners are secure and all joints move as specified. Have the instructor inspect the robot before applying power.

Lesson 03 | DIY Leg Assembly (Part 1) / Ready Kit Structural Observation

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Identify the structure of a single leg and the assembly sequence

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | DIY: Assemble the front section of one leg using approved diagrams; Ready: Observe the preassembled leg and sketch the joint relationships.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. DIY: Assemble the front section of one leg using approved diagrams; Ready: Observe the preassembled leg and sketch the joint relationships.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

DIY / Ready Kit Differences

DIY Kit: Assemble and inspect the components using official assembly drawings. Ready Kit: Do not disassemble the preassembled body. In Lessons 3–4, identify and simulate the mechanisms; install the four legs in Lesson 5.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 3.

Lesson 04 | DIY Leg Assembly (Part 2) / Ready Kit Mechanism Analysis

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Understand four-leg symmetry and mechanical interference

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | DIY: Complete the remaining leg assemblies; Ready: Compare left/right mirror symmetry and linkage travel ranges.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. DIY: Complete the remaining leg assemblies; Ready: Compare left/right mirror symmetry and linkage travel ranges.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

DIY / Ready Kit Differences

DIY Kit: Assemble and inspect the components using official assembly drawings. Ready Kit: Do not disassemble the preassembled body. In Lessons 3–4, identify and simulate the mechanisms; install the four legs in Lesson 5.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 4.

Lesson 05 | Installing the Four Legs and Identifying Orientation

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Identify the correct mounting position for all four legs

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | With power disconnected, install the four legs using the body's front/rear markings; check each fastener, clearance, and cable harness.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. With power disconnected, install the four legs using the body's front/rear markings; check each fastener, clearance, and cable harness.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

DIY / Ready Kit Differences

DIY Kit: Assemble and inspect the components using official assembly drawings. Ready Kit: Do not disassemble the preassembled body. In Lessons 3–4, identify and simulate the mechanisms; install the four legs in Lesson 5.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 5.

Lesson 06 | Mechanical Inspection and Assembly Acceptance

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Carry out mechanical acceptance checks

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Use the checklist to record loose parts, interference, pinched cables, or reversed left/right components; obtain instructor approval.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Use the checklist to record loose parts, interference, pinched cables, or reversed left/right components; obtain instructor approval.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

DIY / Ready Kit Differences

DIY Kit: Assemble and inspect the components using official assembly drawings. Ready Kit: Do not disassemble the preassembled body. In Lessons 3–4, identify and simulate the mechanisms; install the four legs in Lesson 5.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 6.

Assembly Video Illustrations | Use with Lessons 2–6

The following frames are taken from assembly demonstration videos provided by QADIR. They illustrate components and the order of operations but do not replace official component drawings, screw specifications, left/right leg orientation, factory calibration information, or safety checks.

Figure 1 Identifying Parts and Fasteners



Observe and verify: Identify mounting points, moving joints, and possible interference areas. Disconnect power before assembly and have the instructor check the official assembly documentation for this model.

Figure 2 Assembling Leg Linkages



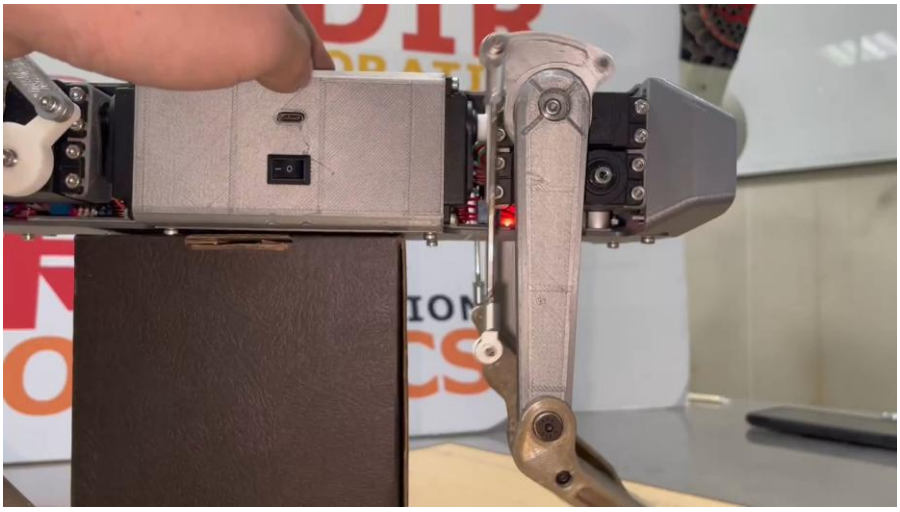
Observe and verify: Identify mounting points, moving joints, and possible interference areas. Disconnect power before assembly and have the instructor check the official assembly documentation for this model.

Figure 3 Joint Assembly Demonstration



Observe and verify: Identify mounting points, moving joints, and possible interference areas. Disconnect power before assembly and have the instructor check the official assembly documentation for this model.

Figure 4 Attaching the Leg to the Body



Observe and verify: Identify mounting points, moving joints, and possible interference areas. Disconnect power before assembly and have the instructor check the official assembly documentation for this model.

Figure 5 Installing the Joint on the Opposite Side



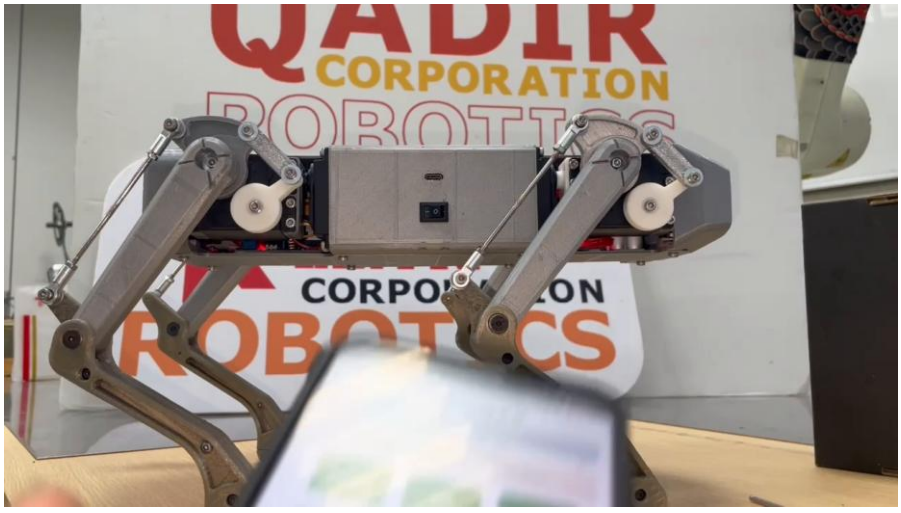
Observe and verify: Identify mounting points, moving joints, and possible interference areas. Disconnect power before assembly and have the instructor check the official assembly documentation for this model.

Figure 6 Checking Leg Fasteners



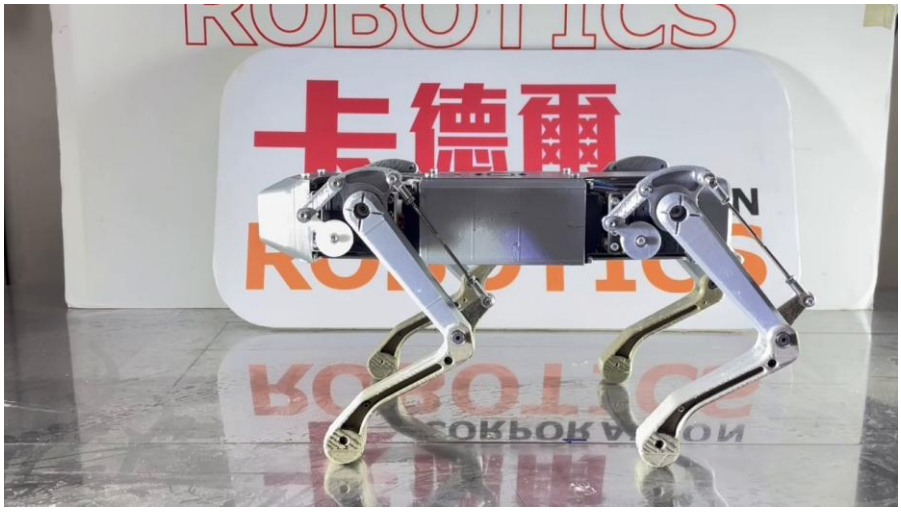
Observe and verify: Identify mounting points, moving joints, and possible interference areas. Disconnect power before assembly and have the instructor check the official assembly documentation for this model.

Figure 7 Mobile Control Interface



Observe and verify: Identify mounting points, moving joints, and possible interference areas. Disconnect power before assembly and have the instructor check the official assembly documentation for this model.

Figure 8 Motion Test After Assembly



Observe and verify: Identify mounting points, moving joints, and possible interference areas. Disconnect power before assembly and have the instructor check the official assembly documentation for this model.

Lesson 07 | EDU Mini Servos, Joints, and 12 DOF

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Identify all 12 actuated joints

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Number the three joints on each of the four legs; record expected movements and actual mechanical limits.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Number the three joints on each of the four legs; record expected movements and actual mechanical limits.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 7.

Lesson 08 | ESP32, Power, and Signal Systems

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Understand the roles of the ESP32 and power system

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Draw a block diagram showing battery → power supply → controller → motors; do not guess pin assignments or supply voltage.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Draw a block diagram showing battery → power supply → controller → motors; do not guess pin assignments or supply voltage.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Describe the key operating steps, acceptance method, and one potential risk for Lesson 8.

Lesson 09 | First Power-On and Safety Checks

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Complete the first power-on checks

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | After the instructor verifies firmware and battery status, elevate the body and power on using the official factory procedure.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. After the instructor verifies firmware and battery status, elevate the body and power on using the official factory procedure.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 9.

Lesson 10 | Mobile App Operation and Motion Observation

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Observe remote-controlled movements and safe stopping

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Use the approved App to perform one low-risk motion and record posture, response, and stopping method.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Use the approved App to perform one low-risk motion and record posture, response, and stopping method.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

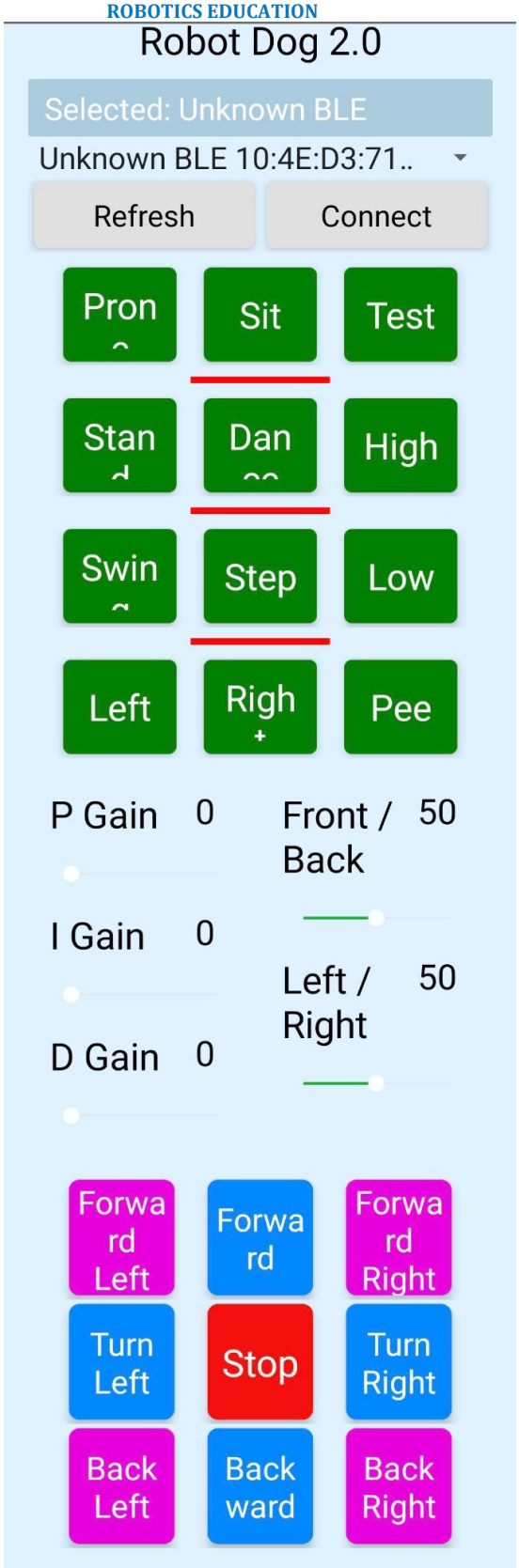
□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 10.

Lesson 10 Supplement | Robot Dog 2.0 App Guide

The illustration below shows the EDU Mini mobile control interface. Place the robot on a level, clear surface before connecting via Bluetooth and testing its motions.


Robot Dog 2.0
Selected: Unknown BLE
Unknown BLE 10:4E:D3:71..
Refresh
Connect
Pron
Sit
Test
Stan
Dan
High
Swin
Step
Low
Left
Righ
Pee
P Gain 0
I Gain 0
D Gain 0
Front / Back 50
Left / Right 50
Forwa rd Left
Forwa rd
Forwa rd Right
Turn Left
Stop
Turn Right
Back Left
Back ward
Back Right

1. Bluetooth Connection Area

Device list: Select the BLE device to connect to. Refresh: Search for devices again. Connect: Establish a connection. “Unknown BLE” is only the displayed scan name and does not prove that EDU Mini is connected; verify the actual device identity and connection status.

2. Posture and Preset Motion Buttons

Prone (shown as “Pron”): Lie down; Sit: Sit; Stand (shown as “Stan”): Stand up; Dance (“Dan”): Dance; Test: Test motion; High / Low: Higher / lower posture; Step: Step in place; Swing (“Swin”): Swing motion. “Pee” denotes a particular novelty action. These interpretations are based on the button names; actual behavior depends on the QADIR factory App and firmware.

3. Fine-Adjustment Sliders

P Gain: Proportional gain; I Gain: Integral gain; D Gain: Derivative gain. These are generally PID control settings, not factory servo angle calibration values. Different firmware versions may use different control loops. Students should observe the values only and not change them without QADIR-confirmed limits.

Front / Back: Front-back adjustment; Left / Right: Lateral adjustment. The initial screen shows 50, but whether 50 is neutral, the unit, and the adjustment range must be confirmed in the actual App software; do not assume these values represent angles or speed.

4. Direction and Stop Buttons

Forward: Move forward; Backward: Move backward; Turn Left / Turn Right: Turn left / right; Forward Left / Forward Right: Move diagonally forward-left / forward-right; Back Left / Back Right: Move diagonally backward-left / backward-right; Stop: Stop.

Operating sequence: ① Check the mechanism and battery → ② Select and connect to the correct BLE device → ③ Test Stand / Stop first → ④ Try low-risk motions one at a time → ⑤ Record button presses and robot responses.

⚠ Safety reminder: Before the first operation, make sure the robot cannot collide with people or fall from the edge of a table. The App’s Stop button must not be treated as an emergency stop device that complies with machinery safety standards.

Student record: BLE device name _____; Connected successfully ☐ Yes ☐ No; Stand response _____; Stop response _____; Fine-adjustment values observed _____.

Lesson 11 | Installing Thonny, USB Connection, and Serial Ports

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Establish a development connection between the computer and ESP32

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Install Thonny, connect a data cable, and select the MicroPython (ESP32) interpreter and serial port.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Install Thonny, connect a data cable, and select the MicroPython (ESP32) interpreter and serial port.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Thonny Connection Steps

1. Use the Thonny installation source and version approved by the instructor.

2. Connect the ESP32 with a data-capable USB cable. If it is not detected, check the driver and cable.

3. In Thonny, select "MicroPython (ESP32)" and the correct port.

4. Open the Shell and verify that the connection works without overwriting the existing firmware.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

Why might a charging-only USB cable fail to upload programs?

Lesson 12 | Flashing MicroPython Firmware and Verifying the Version

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Understand the difference between firmware and programs

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Verify the current firmware version and back up original settings; demonstrate flashing only after instructor approval and successful backup.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Verify the current firmware version and back up original settings; demonstrate flashing only after instructor approval and successful backup.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Firmware Flashing Boundaries

First document the ESP32 chip model, board type, current firmware version, and backup status. Only after QADIR confirms support for the retail hardware version and supplies the matching firmware and recovery method should the instructor demonstrate Thonny's "Install or update MicroPython" procedure. Students must not download arbitrary ESP32 firmware to overwrite the factory software.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

How is flashing firmware different from saving hello.py?

Lesson 13 | Your First Program: Running, Saving, and Uploading

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Run and save your first program

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Run print in the Thonny Shell, then save hello.py to the computer and an approved device.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Run print in the Thonny Shell, then save hello.py to the computer and an approved device.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Saving a Program to the ESP32

Test the code in the Shell → File > Save as → save to This computer first → after instructor approval, save to MicroPython device. main.py may run automatically at startup. For your first exercise, use hello.py to avoid overwriting the factory main.py.

Python / MicroPython Practice

```
print("Hello, EDU Mini!")
robot = "EDU Mini"
print(robot)
```

Observe and reflect: Change a value or string, predict the output, and run the program to verify. This example practices programming syntax only; it does not directly drive EDU Mini motors.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

Why should you avoid overwriting main.py in your first exercise?

Lesson 14 | Python Basics (1): Output, Variables, and Types

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Master output, comments, variables, and data types

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Create variables for the robot name, number of legs, and battery status; examine type() output.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Create variables for the robot name, number of legs, and battery status; examine type() output.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Python / MicroPython Practice

```
robot = "EDU Mini"
legs = 4
dof = 12
print(robot, legs, dof)
print(type(dof))
```

Observe and reflect: Change a value or string, predict the output, and run the program to verify. This example practices programming syntax only; it does not directly drive EDU Mini motors.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 14.

Lesson 15 | Python Basics (2): Operators and Conditional Logic

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Use comparisons and conditional branches

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Write an if/elif/else program to determine whether testing is permitted using a simulated battery value.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Write an if/elif/else program to determine whether testing is permitted using a simulated battery value.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Python / MicroPython Practice

```
battery = 72  # Simulated teaching value, not a reading from the physical robot
if battery < 20:
    print("Stop testing")
elif battery < 50:
    print("Check battery first")
else:
    print("Simulation practice may proceed")
```

Observe and reflect: Change a value or string, predict the output, and run the program to verify. This example practices programming syntax only; it does not directly drive EDU Mini motors.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 15.

Lesson 16 | Python Basics (3): Loops and Timing

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Understand repetition and delays

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Use for to simulate numbering four legs and practice counting with a safely terminating while loop.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Use for to simulate numbering four legs and practice counting with a safely terminating while loop.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Python / MicroPython Practice

```
for leg in range(1, 5):
    print("Leg", leg)
count = 0
while count < 3:
    print("step", count)
    count += 1
```

Observe and reflect: Change a value or string, predict the output, and run the program to verify. This example practices programming syntax only; it does not directly drive EDU Mini motors.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 16.

Lesson 17 | Python Basics (4): Functions and Parameters

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Encapsulate repeated work in functions

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Define report_joint(leg, joint), pass arguments, and check the return value.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Define report_joint(leg, joint), pass arguments, and check the return value.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Python / MicroPython Practice

```
def report_joint(leg, joint):
    return f"{leg}: {joint}"
print(report_joint("front_left", "hip"))
```

Observe and reflect: Change a value or string, predict the output, and run the program to verify. This example practices programming syntax only; it does not directly drive EDU Mini motors.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 17.

Lesson 18 | Python Basics (5): Lists and Dictionaries

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Represent joints and motions with data structures

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Use a list to store the four leg names and a dict to store three joint names for each leg.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Use a list to store the four leg names and a dict to store three joint names for each leg.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Python / MicroPython Practice

```
legs = ["front_left", "front_right", "rear_left", "rear_right"]
joints = {leg: ["hip", "thigh", "knee"] for leg in legs}
print(joints["front_left"])
```

Observe and reflect: Change a value or string, predict the output, and run the program to verify. This example practices programming syntax only; it does not directly drive EDU Mini motors.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 18.

Lesson 19 | Modular Programming, Exception Handling, and Debugging

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Read errors and debug in stages

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Intentionally trigger NameError and TypeError; log errors using try/except.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Intentionally trigger a ValueError and record the error with try/except.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Python / MicroPython Practice

```
try:
    angle = int("invalid")
except ValueError as err:
    print("Invalid data format:", err)
```

Observe and reflect: Change a value or string, predict the output, and run the program to verify. This example practices programming syntax only; it does not directly drive EDU Mini motors.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 19.

Lesson 20 | Joint Angles, Control Interfaces, and Safety Limits

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Distinguish simulated angles from physical robot control

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Check angle ranges in a software example first; use only QADIR-approved APIs for physical robot calls.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Check angle ranges in a software example first; use only QADIR-approved APIs for physical robot calls.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Python / MicroPython Practice

```
def check_angle(angle, low=-30, high=30):
    # Demonstration range, not the safe limits of a physical EDU Mini
    return low <= angle <= high
print(check_angle(15))
```

Observe and reflect: Change a value or string, predict the output, and run the program to verify. This example practices programming syntax only; it does not directly drive EDU Mini motors.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

Why can't simulated angle limits be used directly as the safe motion range of the physical robot?

Lesson 21 | Posture, Center of Gravity, and Standing Stability

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Understand support polygons and the center of gravity

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Sketch different combinations of supporting legs and explain when the robot is likely to tip.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Sketch different combinations of supporting legs and explain when the robot is likely to tip.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 21.

Lesson 22 | Gait Principles and Parameters

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Understand gait phases and stride length

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Use paper cards or simulated data to create a four-leg lift/place sequence and analyze stability.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Use paper cards or simulated data to create a four-leg lift/place sequence and analyze stability.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 22.

Lesson 23 | Forward, Backward, and Turning Motions

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Identify direction-control parameters

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Compare diagrams of foot trajectories for forward, backward, and turning movements; record differences.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Compare diagrams of foot trajectories for forward, backward, and turning movements; record differences.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 23.

Lesson 24 | Motion Sequences and Data Logging

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Create reproducible motion records

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Design fields for action name, time, test results, anomalies, and version.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Design fields for action name, time, test results, anomalies, and version.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Python / MicroPython Practice

```
log = {"action":"demo", "duration_s":2, "result":"observed"}
print(log)
```

Observe and reflect: Change a value or string, predict the output, and run the program to verify. This example practices programming syntax only; it does not directly drive EDU Mini motors.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 24.

Lesson 25 | Basic Kinematics and Motion Improvement

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Understand the relationship between joint angles and foot positions

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Calculate a foot position with a simplified two-link model and discuss differences from the physical robot's three-joint leg.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Calculate a foot position with a simplified two-link model and discuss differences from the physical robot's three-joint leg.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Python / MicroPython Practice

```
import math
L1, L2 = 5.0, 6.0  # Assumed lengths (cm)
a, b = math.radians(30), math.radians(45)
x = L1*math.cos(a) + L2*math.cos(a+b)
y = L1*math.sin(a) + L2*math.sin(a+b)
print(round(x,2), round(y,2))
```

Observe and reflect: Change a value or string, predict the output, and run the program to verify. This example practices programming syntax only; it does not directly drive EDU Mini motors.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

☐ Task completed ☐ Evidence recorded ☐ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 25.

Lesson 26 | Project Design and Experimental Planning

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Propose a testable project

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Write objectives, variables, controlled conditions, measurement methods, risks, and team responsibilities.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Write objectives, variables, controlled conditions, measurement methods, risks, and team responsibilities.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 26.

Lesson 27 | Project Implementation and Testing

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Complete group experiments and revisions

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Carry out an instructor-approved experiment, record data, analyze failures, and improve the design.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Carry out an instructor-approved experiment, record data, analyze failures, and improve the design.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 27.

Lesson 28 | Project Presentation, Assessment, and Reflection

Lesson duration: 50 minutes | Student practice and records

Learning Objectives

Clearly present results and limitations

Lesson Plan (50 minutes)

0–8 min | Review the previous lesson, safety, and today's objectives

8–18 min | Instructor demonstration or concept explanation

18–38 min | Submit code, operating records, problem analysis, presentation slides, and peer feedback.

38–46 min | Group checks, troubleshooting, and documentation

46–50 min | Wrap up, submit work, and preview next lesson

Student Hands-On Tasks

1. Submit code, operating records, problem analysis, presentation slides, and peer feedback.

2. Record operating conditions, versions, observations, and photos/screenshots on the worksheet.

3. Describe problems encountered, possible causes, and improvements to try next time.

Lesson Worksheet

Prediction (What do I think will happen?):_____

Actual observations / output:_____

Problems encountered:_____

Cause analysis / next steps:_____

□ Task completed □ Evidence recorded □ Safety procedures followed

Review Question

Describe the key operating steps, acceptance method, and one potential risk for Lesson 28.

Appendix A | Ready Kit Four-Leg Installation Checklist

Inspection Item	Result / Notes
Body front/rear orientation confirmed	☐ Yes ☐ No
Four leg positions and left/right orientation verified	☐ Yes ☐ No
Fasteners and linkages complete	☐ Yes ☐ No
Wiring harness free of pinching, pulling, or interference	☐ Yes ☐ No
Normal motion range with power disconnected	☐ Yes ☐ No
Instructor approved initial power-on	Signature: _____

Appendix B | ESP32 Development Checklist

☐ Confirm the retail ESP32 board type and USB connection method

☐ Verify the Thonny version and correct serial port

☐ Record the original firmware version and back up required files

☐ Understand the difference between flashing firmware and uploading a .py program

☐ Test with hello.py without overwriting the factory main.py

☐ Have Engineering confirm the actual control API, factory calibration status, and safe joint limits

Appendix C | Engineering Verification Items Before Publication

QADIR must confirm: four-leg installation orientation and drawing numbers; screw and washer part numbers; factory servo calibration and joint limits; exact ESP32 model; power architecture; firmware version and recovery

procedure; Thonny connection support; official motor control API; and App/Bluetooth operating procedures.

Each video screenshot should correspond to an official assembly step and component revision. Until verified, screenshots must not be the sole assembly reference.

Appendix D | Student Practice and Results Record for 28 Lessons

This worksheet format may be photocopied for each lesson. Students must record actual observations, measurements, and reasons for corrections; estimates must not be presented as measured results.

Lesson 01 | Getting to Know EDU Mini, Learning Objectives, and Operational Safety

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 02 | Identifying Parts, Tools, and Assembly Preparation

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 03 | DIY Leg Assembly (Part 1) / Ready Kit Structural Observation

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 04 | DIY Leg Assembly (Part 2) / Ready Kit Mechanism Analysis

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 05 | Installing the Four Legs and Identifying Orientation

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 06 | Mechanical Inspection and Assembly Acceptance

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 07 | EDU Mini Servos, Joints, and 12 DOF

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 08 | ESP32, Power, and Signal Systems

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 09 | First Power-On and Safety Checks

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 10 | Mobile App Operation and Motion Observation

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 11 | Installing Thonny, USB Connection, and Serial Ports

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 12 | Flashing MicroPython Firmware and Verifying the Version

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 13 | Your First Program: Running, Saving, and Uploading

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 14 | Python Basics (1): Output, Variables, and Types

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 15 | Python Basics (2): Operators and Conditional Logic

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 16 | Python Basics (3): Loops and Timing

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 17 | Python Basics (4): Functions and Parameters

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 18 | Python Basics (5): Lists and Dictionaries

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 19 | Modular Programming, Exception Handling, and Debugging

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 20 | Joint Angles, Control Interfaces, and Safety Limits

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 21 | Posture, Center of Gravity, and Standing Stability

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 22 | Gait Principles and Parameters

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 23 | Forward, Backward, and Turning Motions

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 24 | Motion Sequences and Data Logging

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 25 | Basic Kinematics and Motion Improvement

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 26 | Project Design and Experimental Planning

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Lesson 27 | Project Implementation and Testing

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Date / Class / Group	_____
Lesson Activity or Exercise	_____
Actual Observations / Results	_____
Problems, Errors, and Corrections	_____
Instructor Confirmation / Next Steps	_____

Appendix D-1 | MicroPython Quick Reference

The following are common ESP32 MicroPython syntax forms and functions. Actual support depends on the firmware version. The examples are for learning only and do not directly drive EDU Mini servos.

print(x) | Display a message or variable value
Example: print("Hello EDU Mini")

input("prompt") | Read user input (requires an available terminal interface)
Example: name = input("Name: ")

comment | Add an explanation in the code
Example: # This is a comment

= | Assign a value to a variable
Example: speed = 3

type(x) | Inspect the data type
Example: print(type(12))

int(x) / float(x) / str(x) | Convert between numeric and text types
Example: n = int("12")

if / elif / else | Execute statements conditionally
Example: if n > 0: print("OK")

for ... in range(n) | Repeat a specified number of times
Example: for i in range(3): print(i)

while condition | Repeat while a condition is true
Example: while False: pass

break / continue | Exit a loop / skip this iteration
Example: if i == 2: break

def / return | Define a function and return a result
Example: def add(a,b): return a+b

list / dict | Store lists and key-value data
Example: angles = [0, 10, 20]

len(x) | Count elements
Example: print(len(angles))

append(x) | Append an item to a list
Example: angles.append(30)

enumerate(x) | Get an index and an element together
Example: for i,v in enumerate(angles): print(i,v)

import / from ... import | Import a module
Example: import time

time.sleep(s) | Pause for the specified number of seconds
Example: time.sleep(1)

time.sleep_ms(ms) | Pause for the specified number of milliseconds
Example: time.sleep_ms(200)

try / except | Catch and handle runtime errors
Example: try: x = 1/0
except ZeroDivisionError: print("Error")

open / with | Read and write files (mind device storage capacity)
Example: with open("log.txt","w") as f: f.write("OK")

machine.Pin | Configure ESP32 GPIO pins (confirm physical pin assignments first)
Example: from machine import Pin

machine.PWM | Generate a PWM signal (do not use directly with an unverified motor interface)
Example: from machine import PWM

os.listdir() | List files on the device
Example: import os; print(os.listdir())

help() | View help for available objects
Example: help("modules")

⚠ Programming Reminder | Do Not Overwrite Factory Files

Note: Standard Python and MicroPython are not identical. Some desktop Python packages cannot run on the ESP32. Do not overwrite the EDU Mini factory main.py / boot.py unless you have backed them up and confirmed the recovery procedure according to QADIR instructions.

Appendix E | MicroPython Exercises (Can Be Tested Offline)

The following examples demonstrate syntax only; they will not drive the EDU Mini motors. Physical robot control must use interfaces approved by QADIR and compatible with the factory firmware version.

Output, Variables, and Data Types

```
name = "EDU Mini"
legs = 4
dof = 12
print(name, legs, dof)
```

Conditional Statements

```
battery_ok = True
if battery_ok:
    print("Ready for checks")
else:
    print("Stop and inspect")
```

Loops and Lists

```
joints = ["front-left", "front-right", "rear-left", "rear-
right"]
for index, name in enumerate(joints):
```

```
    print(index, name)
```

Functions and Parameters

```
def clamp(value, low, high):
    return max(low, min(value, high))

print(clamp(120, 0, 90))
```

Dictionaries and Logging

```
record = {"trial": 1, "stable": False, "note": "observe"}
print(record["trial"], record["note"])
```

Exception Handling

```
try:
    value = int("12")
    print(value)
except ValueError:
    print("Invalid input")
```

Appendix F | Verification Checklist

□ Ready Kit leg orientation (front/rear, left/right), fasteners, and screw specifications

□ Factory calibration, allowable angles, motion limits, and pre-power-on checks

□ Factory ESP32 firmware version, flashing authorization, and backup/recovery procedure

□ Thonny serial-port and MicroPython version compatibility

□ Actual motor control API, App pairing procedure, and wiring documentation

□ Verify that all images match the production version of the product

□ Licensing boundaries for public learning materials and purchaser-only firmware, App, and full programs

Document status: Complete integrated 28-lesson student workbook. Sections concerning model-specific physical parameters and firmware operations require QADIR Engineering approval before this can serve as an official public operating manual.

QADIR EDU Mini

Make Hands-On Practice the Starting Point for Understanding Robotics

Student Hands-On Workbook | 28 Lessons | V5.5

This workbook is for EDU Mini DIY Kit and Ready Kit. Follow the official product instructions and your instructor's guidance. For hardware wiring, firmware, and control interfaces, follow the version approved by QADIR.

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