Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

SHORT COURSE

FISH FARMING AND PROCESSING

FFWQ001
Management of Water Quality

TRAINER'S MANUAL

August 2025

Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

MANAGEMENT OF WATER QUALITY

LUXEMBOURG AID & DEVELOPMENT

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LIST OF ABBREVIATIONS AND ACRONYMS

AM: Ante Meridiem (before midday

Ca^{2}: Calcium

CBET: Competency-Based Education and Training

CBT: Competency Based Training

Cl^{-}: Chloride

DO: Dissolved Oxygen

e.g: Example

EU: European Union

F^{-}: Fluoride

ID: Identity

ISEs: Ion Selective Electrodes

IT: Information Technology

mg/L: Milligram Per Litter

NH3- : Nitrate

NH4+: Ammonia

NTU: Nepphelometric Turbidity Unit

pH: Potential Hydrogen

RTB: Rwanda TVET Board

TVET: Technical and Vocational Education and Training

INTRODUCTION

This trainer's manual encompasses all necessary skills, knowledge and attitudes required to Manager water quality. Students undertaking this module shall be exposed to practical activities that will develop and nurture their competences. The writing process of this training manual embraced competency-based education and training (CBET) philosophy by providing practical opportunities reflecting real life situations.

The trainee's manual is subdivided into units, each unit has got various topics, you will start with a self-assessment exercise to help you rate yourself on the level of skills, knowledge, and attitudes about the unit. A discovery activity is followed to help you discover what you already know about the unit.

After these activities, you will learn more about the topics by doing different activities by reading the required knowledge, techniques, steps, procedures, and other requirements under the key facts section, you may also get assistance from the trainer. The activities in this training manual are prepared such that they give opportunities to students to work individually and in groups.

After going through all activities, you shall undertake progressive assessments known as formative and finally conclude with your self-reflection to identify your strengths, weaknesses, and areas for improvement.
Do not forget to read the point to remember the section which provides the overall key points and takeaways of the unit.

Management of water quality

Learning Outcomes	Learning Hours	Topics
1. Prepare tools and equipment	30H	1.1. Preparation of water quality tools and equipment
		1.2. Calibration of tools and equipment
		1.3. Storage of water quality tools, materials and Equipment
2. Assess water quality	40H	2.1. Taking water samples to the laboratory
		2.2. Measurement of water quality parameters
		2.3. Recording of water quality parameter readings
		2.4. Interpretation of water quality parameters
3. Correct water quality parameters	30H	3.1. Identification of deviations from water quality standards
		3.2. Implementation of corrective measures for water quality parameter deviations
		3.3. Preparation of water quality reports

LEARNING OUTCOME 1: PREPARING TOOLS AND EQUIPMENT

Learning outcome 1: Self-Assessment

1. Ask trainees to look at the unit illustration in their Trainee's Manuals and together discuss:

   What does the illustration show?

   What do you think will be topics to be covered under this unit based on the illustration?

2. After the discussion, inform students that this unit is intended to provide them with the knowledge, skills and attitudes to prepare tools and equipment. They will cover the skills required to Preparation of water quality tools and equipment, C

3. calibration of tools and equipment and Storage of water quality tools, materials and Equipment

4. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee's Manuals. Explain that:

   a. The purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning.

   b. There are no right or wrong ways to answer this assessment. It is for their own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.

   c. They should think about themselves: do they think they have the knowledge, skills or attitudes to do this? How well?

   d. They read the statements across the top and put a check in column that best represents their level of knowledge, skills or attitudes.

   e. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas of improvement and actions to be taken.

Key Competencies:

Knowledge	Skills	Attitudes
1. Identify water quality tools and equipment	1. Select water quality tools and equipment	1. Attention to detail when preparing tools and equipment
2. Follow safety protocols during preparation	2. Prepare water quality tools and equipment	2. Commitment to safety and hygiene
3. Understand the importance of accurate calibration	3. Calibrate tools and equipment to ensure accuracy	3. Pay attention to detail when calibrating tools and equipment
4. Understand types of tools, materials, and equipment	4. Organize water quality tools, materials, and equipment	4. Attention to detail when organizing water tools, materials, and equipment
5. Understand proper storage conditions	5. Store water quality tools, materials, and equipment	5. Be detail-oriented and organized.

Steps:

Discovery activity

Task 1

1. Using an appropriate methodology such as pair-share, large group discussion and presentation, the objective is to foster engagement and knowledge exchange among students.
2. Take students through the following steps:
    a. Firstly, organize trainees into pairs or small groups and guide them through a structured discussion about questions on **task 1** in trainee's manual. Ensure active participation and understanding of instructions.
    b. Secondly, bring the trainees back together as a large group for presentations. Each pair or group should summarize their discussions, sharing insights and learnings with the class. Encourage all trainees to contribute their own experiences and reflections.
    c. Conclude the activity with feedback and reflection. Emphasize that the purpose was not to find right answers but to provide a look into trainees' scheduling of laundry roaster.
3. Introduce Topic 1.1: Preparation of water quality tools and equipment

Topic 1.1 Preparation of water quality tools and equipment

Objectives:

By the end of the topic, trainees will be able to:

a. Identify properly water quality tools and equipment as used in fish farming
b. Distinguish correctly the selection criteria for tools and equipment as used in fish farming

c. Identify properly the water quality parameters in fish farming.

d. Prepare correctly water quality and equipment according to the task to be done.

Time Required: 8 hours.

Learning Methodology:

Group discussion, brainstorming, presentation, Think-Pair-square-share, pair work, Individual work, demonstration, observation, role-play, field visit

Materials, Tools and Equipment Needed:

✓ Multi parameter, Dissolved oxygen meter, pH meter, Colorimeter, Turbidity meter, sampling bottles, Thermometers, temperature probes, pH meter, Ammonia test kits, secchi disk, conductivity meter, test strips and flow meter.

Preparation:

- ❑ Read and understand the scenario before giving it to the students
- ❑ Gather in advance tools, materials, and equipment needed to deliver the session.
- ❑ Arrange a conducive learning environment

Cross Cutting Issues:

✓ **Gender balance:** Mix girls and boys in order to promote cross-gender interaction. Encourage both genders to take on roles of leadership.

✓ **Inclusive education:** Ensure inclusivity while allocating tasks to students and provide facilities/environment that enable/allows participation of all.

Prerequisites:

- ▸ Practice occupational health and safety procedures

Activity 1: Problem-Solving

Task 2

1. Using various methodologies like pair-share, or small group discussions, Instruct the trainees to join their respective groups and read the following scenario:

   A tilapia farm located in Nyamabuye sector is entering the dry season. The farm manager plans to conduct weekly water quality checks to maintain optimal conditions for fish growth and prevent disease outbreaks. Before testing begins, the team must prepare all tools and equipment to ensure accurate and safe monitoring.

2. Tell them to discuss and answer the following questions:
   1. What are water quality tools and equipment would you recommend for use on the farm?
   2. Differentiate between a pH meter and a conductivity meter in terms of their function.
   3. What is the purpose of Dissolved Oxygen meters in water quality testing?
   4. What are the selection criteria for water quality tools and equipment would you recommend the farm to follow?

   - ✓ Allow 10-15 minutes for discussion.
   - ✓ Move around the classroom to check progress and provide clarification if any.
   - ✓ Nominate or tell the group to nominate one speaker to share the findings of the group
   - ✓ Give 2-3 minutes per group

3. After all groups present, thank them and then provide the correct responses:
   1. The water quality tools and equipment to be recommend for use on the farm are the **Multi-Parameter meter** which is the best equipment because it can test necessary parameters alone and it is portable.
      alternatives: pH meter, DO meter, conductivity meter, Thermometer, etc.
   2. Different between a pH meter and a conductivity meter in terms of their function:

   - ➢ **pH meter** is a scientific instrument used to measure the acidity or alkalinity of a solution by detecting the concentration of hydrogen ions (H^+) while A **conductivity meter** is an instrument used to measure the electrical conductivity of a liquid — which reflects how well the solution can carry an electric current.

3. The purpose of Dissolved Oxygen meters in water quality testing is: to measure the amount of oxygen gas dissolved in water.
4. The selection criteria for water quality tools and equipment to be recommended to the farm are:
    - Costs associated (transport, taxes)
    - Sensitivity
    - Precision
    - Accuracy
    - Availability of spares
    - Durability
    - Material

4. Wrap up by Highlighting key points related to the scenario:

    - Identification of the water quality tools and equipment and their functions
    - Identification of selection criteria for water tools and equipment

5. After the sharing session, let trainees to the Key facts 1.1 for further enhancement.

Activity 2: Guided Practice

Task 3

1. Using an appropriate methodology such as individual work, pair-share, small group work, guide trainees to carry out the activities provided under **task 3** in their Trainee's Manuals. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
2. During the task, trainees should be given a degree of independence to apply the knowledge and skills acquired in activity. Attend to each group, individual and provide support where necessary. Your role is to guide them by using probing questions such as Why? What? How? to enable them to come to informed responses.
3. While trainees are still performing the task, use this opportunity to discuss or address cross-cutting issues that may arise such as gender, inclusivity, financial education among others, even during group formation. Also attitudes and behavior changes should be handled during this activity.

4. Using an appropriate methodology such as question and answer in a large group, pair presentations or small group presentations, guide trainees to share their answers to the class. Write their responses for reference. Encourage all trainees to give their views.
5. After the sharing session, refer trainees to Key Facts 1.1, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have.
6. Use the observation/performance checklist below while assessing the preparation of the necessary water quality tools and equipment.

Indicator (Elements to be checked)	Observation		Marks allocation
	Yes	No	
✓ Dissolved Oxygen meter is selected			
✓ DO sampling bottles is selected			
✓ Thermometers is selected			
✓ Temperature probes is selected			
✓ pH meter is selected			
✓ Turbidity meter is selected			
✓ Conductivity meter is selected			
✓ Ammonia test kits is selected			
✓ Selected tools and equipment are checked (in good working condition)			
✓ Batteries or power sources are available and functional			

Activity 3: Application

Task 4

1. Using an appropriate methodology such as individual work, pairs, or small groups, trainees will read the statement provided on **task 4** in the trainees' manual and perform the task. Ensure that all instructions are clear and understood by the trainees, and encourage active participation among all students. This activity requires students to work independently with limited support from the trainer.
2. Provide necessary materials and tools for the task to be completed effectively.
3. Let the trainees Identify suitable workplaces for them or identify workplace for them, which may include:
   - ✓ Locations within the school compound
   - ✓ Local farms
4. Encourage trainees to actively observe technicians as they perform their tasks.
5. Allow trainees to participate in hands-on activities whenever possible to gain practical experience.
6. Encourage trainees to ask as many questions as possible regarding:
   - ✓ The tasks being performed
   - ✓ Tools and equipment in use
   - ✓ Best practices and safety measures
7. After the visit, have each trainee write a report that includes:
   - ✓ An overview of the workplace
   - ✓ Key observations and experiences
   - ✓ Answers to questions raised during the visit
8. Organize a session for trainees to present their reports to the class.
9. Facilitate a discussion to encourage sharing of insights and foster collaborative learning.

Topic 1.2: Calibration of tools and equipment

Objectives:

By the end of the topic, trainees will be able to:

a. Define correctly the term calibration used in water quality management.
b. Explain properly the importance of calibration of tools and equipment used in water quality management.
c. Distinguish correctly the methods of calibration for tools and equipment used in water quality management.
d. Demonstrate appropriately the procedures for calibrating water quality measuring tools and equipment.
e. Calibrate correctly tools and equipment used in water quality management.

Time Required: 12hours.

Learning Methodology:

Group discussion, brainstorming, presentation, Think-Pair-square-share, pair work, Individual work, demonstration, observation, role-play, field visit

Materials, Tools and Equipment Needed:

✓ Reference equipment, Standards thermometer, pH buffer solutions, Clean soft clothes, Clean brushes, cleaning solutions, recording data sheet and distilled water

Preparation:

- ❑ Read and understand the scenario before giving it to the students
- ❑ Gather in advance tools, materials, and equipment needed to deliver the session.
- ❑ Arrange a conducive learning environment

Cross Cutting Issues:

- ✓ **Gender balance:** Mix girls and boys in order to promote cross-gender interaction. Encourage both genders to take on roles of leadership.
- ✓ **Inclusive education:** Put trainees into different mixed-ability groups. If there are, trainees with disabilities mix them with others. If there are some with hearing disabilities or communication difficulties, you should always get their attention on before you begin to speak and encourage them to look at your face when you speak.
- ✓ **Critical thinking:** Give activities which enhance critical thinking
- ✓ **Communication:** Encourage every group member to participate in discussions and/or oral presentations

Prerequisites:

- Occupational health and safety procedures

Activity 1: Problem-Solving

Task 5

Problem solving in Trainer manual

1. Using various methodologies like pair-share, or small group discussions, Instruct the trainees to join their respective groups and read the following scenario:

   Mr. John is a field technician working for a regional water quality monitoring agency. He is scheduled to take water quality measurements from three monitoring sites along a river. After taking the measurements on the first site, He got the wrong results because the tools and equipment used were not calibrated before taking the measurements.

2. Tell them to discuss and answer the following questions:

   1. What is calibration?

2. Why is it important to calibrate tools and equipment before collecting data?
3. What are the procedures to follow in the calibration of water quality tools and equipment?
4. What are calibration methods will consider during the calibration of water quality tools and equipment?
   - ✓ Allow 10-12 minutes for discussion.
   - ✓ Move around the classroom to check progress and provide clarification if any.
   - ✓ Nominate or tell the group to nominate one speaker to share the findings of the group
   - ✓ Give 2-3 minutes per group

6. After all groups present, thank them and then provide the correct responses:
   1. Calibration refers to the process of adjusting and verifying that measuring instruments provide accurate readings, especially when monitoring key water quality parameters like pH, temperature, dissolved oxygen (DO), conductivity, etc.
   2. The importance of calibration of tools and equipment before collecting data is as follows:

      Calibration is essential because it ensures accuracy and reliability of measurements, making data trustworthy over time. It supports quality control and compliance with industry or regulatory standards. By preventing costly errors and detecting issues early, calibration protects both operations and equipment. Ultimately, it helps maintain safe, optimal conditions while extending the lifespan of tools.

   3. The procedures to follow in the calibration of water quality tools and equipment are the following:
   - ➢ Equipment cleaning
   - ➢ Equipment cleaning
   - ➢ Preparation of calibration solution
   - ➢ Immersion of equipment sensor in solution
   - ➢ Waiting for stabilization
   - ➢ Recording values
   - ➢ Rinsing the equipment/sensor

   4. There are two main calibration methods:
   - ➢ Single-point calibration: Calibrating the instrument using one known standard (e.g., pH 7 buffer).

- Multi-point calibration: Uses two or more known standards to ensure accuracy across a range (e.g., pH 4, 7, and 10 buffers).

7. Wrap up by Highlighting key points related to the scenario:

- Meaning of calibration in water quality management
- The importance of water quality tools and equipment calibration
- Procedures of water quality tools and equipment calibration
- Methods of water quality tools and equipment

8. After the sharing session, let trainees to the Key facts 1.2 for further enhancement.

Activity 2: Guided Practice

Task 6

1. Using an appropriate methodology such as individual work, pair-share, small group work, guide trainees to carry out the activities provided under task 6 in their Trainee's Manuals. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
2. During the task, trainees should be given a degree of independence to apply the knowledge and skills acquired in activity. Attend to each group, individual and provide support where necessary. Your role is to guide them by using probing questions such as Why? What? How? to enable them to come to informed responses.
3. While trainees are still performing the task, use this opportunity to discuss or address cross-cutting issues that may arise such as gender, inclusivity, financial education among others, even during group formation. Also attitudes and behavior changes should be handled during this activity.
4. Using an appropriate methodology such as question and answer in a large group, pair presentations or small group presentations, guide trainees to share their answers to the class. Write their responses for reference. Encourage all trainees to give their views.

5. After the sharing session, refer trainees to Key Facts 1.2, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have.
6. Use the observation/performance checklist below while assessing the calibration of water quality tools and equipment.

Indicator (Elements to be checked)	Observation		Marks allocation
	Yes	No	
✓ pH Meter is calibrated			
✓ Dissolved Oxygen (DO) Meter is calibrated			
✓ Conductivity/Salinity Meter is calibrated			
✓ Turbidity Meter is calibrated			
✓ Thermometer is calibrated			

Activity 3: Application

Task 7

1. Using an appropriate methodology such as individual work, pairs, or small groups, trainees will read the statement provided on **task 7** in the trainees' manual and perform the task. Ensure that all instructions are clear and understood by the trainees, and encourage active participation among all students. This activity requires students to work independently with limited support from the trainer.
2. Provide necessary materials and tools for the task to be completed effectively.
3. Let the trainees Identify suitable workplaces for them or identify workplace for them, which may include:
   - ✓ Locations within the school compound
   - ✓ Local farms
4. Encourage trainees to actively observe technicians as they perform their tasks.
5. Allow trainees to participate in hands-on activities whenever possible to gain practical experience.

6. Encourage trainees to ask as many questions as possible regarding:
    - ✓ The tasks being performed
    - ✓ Tools and equipment in use
    - ✓ Best practices and safety measures
7. After the visit, have each trainee write a report that includes:
    - ✓ An overview of the workplace
    - ✓ Key observations and experiences
    - ✓ Answers to questions raised during the visit
8. Organize a session for trainees to present their reports to the class.
9. Facilitate a discussion to encourage sharing of insights and foster collaborative learning.

Topic 1.3: Storage of water quality tools, materials, and Equipment

Objectives:

By the end of the topic, trainees will be able to:

a. Explain correctly the importance of proper storage for water quality tools, materials, and equipment.

b. Demonstrate properly the battery management best practices in water quality management.

c. Inspect correctly the condition of water quality tools, materials, and equipment before storing. Clean properly water quality tools, materials, and equipment according to manufacturer's guidelines.

d. Store properly the water quality tools, material, and equipment.

Time Required: 10 hours.

Learning Methodology:

Group discussion, brainstorming, presentation, Think-Pair-square-share, pair work, Individual work, demonstration, observation, role-play, field visit

Materials, Tools and Equipment Needed:

✓ Sensor Storage Accessories, Storage Containers & Case, Distilled or deionized water, Manufacturer-recommended cleaning solutions, Soft lint-free cloths, Brushes and Mild detergents.

Preparation:

❑ Read and understand the scenario before giving it to the students

	❑ Gather in advance tools, materials, and equipment needed to deliver the session. ❑ Arrange a conducive learning environment
	**Cross Cutting Issues:** ✓ **Gender balance:** Mix girls and boys in order to promote cross-gender interaction. Encourage both genders to take on roles of leadership. ✓ **Inclusive education:** Ensure inclusivity while allocating tasks to students and provide facilities/environment that enable/allows participation of all.
	**Prerequisites:** ▸ Occupational health and safety procedures

Activity 1: Problem-Solving

Task 8

1. Using various methodologies like pair-share, or small group discussions, Instruct the trainees to join their respective groups and read the following scenario: Mr. John is responsible for checking and storing water testing equipment at BAHO fish farm. Last week, someone used various tools and equipment, including pH and DO meters, and returned them to the storage room without cleaning and inspecting.
2. Tell them to discuss and answer the following questions:
    1. Why is it important to clean and inspect water quality tools, materials, and Equipment before storage?
    2. Why is proper storage important?
    3. Why should the batteries be removed before storage?
    4. What should you do to clean and store the equipment properly after use?

        ✓ Allow 10-15 minutes for discussion.

- ✓ Move around the classroom to check progress and provide clarification if any.
- ✓ Nominate or tell the group to nominate one speaker to share the findings of the group
- ✓ Give 2-3 minutes per group

3. After all groups present, thank them and then provide the correct responses:

1. The importance of cleaning and inspecting water quality tools, materials, and Equipment before storage are:
   - ➢ Increase durability: Reduces corrosion, rust, or damage, extending equipment lifespan.
   - ➢ Improve safety: Proper handling and cleaning prevent accidents with chemicals or sharp tools.
   - ➢ Maintain accuracy: Removes dirt and residues that could affect water quality readings.
   - ➢ Prevent contamination: Avoids cross-contamination between different tests or ponds.
   - ➢ Ensure reliability: Regular inspection detects faults, worn-out parts, or low batteries early.
   - ➢ Support good farm management: Guarantees reliable data for decision-making in water quality control.
2. Importance of proper storage
   - ➢ Maintains the accuracy and calibration of instruments.
   - ➢ Extends the lifespan of tools and equipment.
   - ➢ Prevents contamination of sensitive sensors and materials.
   - ➢ Keeps tools organized and ready for the next operation.

3. The reason why the batteries are removed before storage:
   - ➢ Prevents battery leakage, which can corrode and damage the equipment's internal components.
   - ➢ Reduces the risk of power drain when the device is not in use.
   - ➢ Avoids accidents caused by overheated or swollen batteries.
4. For cleaning and storing tools and equipment properly, you should do the following:

- ➢ Rinse sensors and probes with distilled water or manufacturer-recommended cleaning solution.
- ➢ Wipe the battery compartment clean; remove batteries if storing long-term.
- ➢ Store probes upright in airtight containers or calibration cups with the correct storage solution (e.g., pH 4.0 or 7.0 buffer for pH electrodes).
- ➢ Place instruments in padded cases or lockable cabinets in a cool, dry environment (5°C–25°C).
- ➢ Record the cleaning and storage date in the maintenance log.

4. Wrap up by Highlighting key points related to the scenario:
    - Importance of proper storage
    - Battery management
    - Instrument cleaning and inspection
    - Dry and wet storage of sensors and/or cables

5. After the sharing session, let trainees to the Key facts 1.3 for further enhancement.

Activity 2: Guided Practice

Task 9

1. Using an appropriate methodology such as individual work, pair-share, small group work, guide trainees to carry out the activities provided under **task 9** in their Trainee's Manuals. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
2. During the task, trainees should be given a degree of independence to apply the knowledge and skills acquired in activity. Attend to each group, individual and provide support where necessary. Your role is to guide them by using probing questions such as Why? What? How? to enable them to come to informed responses.
3. While trainees are still performing the task, use this opportunity to discuss or address cross-cutting issues that may arise such as gender, inclusivity, financial education among others, even during group formation. Also attitudes and behavior changes should be handled during this activity.
4. Using an appropriate methodology such as question and answer in a large group, pair presentations or small group presentations, guide trainees to share their answers to the class. Write their responses for reference. Encourage all trainees to give their views.
5. After the sharing session, refer trainees to Key Facts 1.3, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have.
6. Use the observation/performance checklist below while assessing the calibration of water quality tools and equipment:

Indicator (Elements to be checked)	Observation		Marks allocation
	Yes	No	
✓ Tools, materials and equipment are properly cleaned			
✓ Tools , materials and equipment are properly inspected			
✓ Tools , materials and equipment are properly stored			

Activity 3: Application

Task 10

1. Using an appropriate methodology such as individual work, pairs, or small groups, trainees will read the statement provided on **task 10** in the trainees' manual and perform the task. Ensure that all instructions are clear and understood by the trainees, and encourage active participation among all students. This activity requires students to work independently with limited support from the trainer.
2. Provide necessary materials and tools for the task to be completed effectively.
3. Let the trainees Identify suitable workplaces for them or identify workplace for them, which may include:
   - ✓ Locations within the school compound
   - ✓ Local farms
4. Encourage trainees to actively observe technicians as they perform their tasks.
5. Allow trainees to participate in hands-on activities whenever possible to gain practical experience.
6. Encourage trainees to ask as many questions as possible regarding:
   - ✓ The tasks being performed

- ✓ Tools and equipment in use
- ✓ Best practices and safety measures

7. After the visit, have each trainee write a report that includes:
   - ✓ An overview of the workplace
   - ✓ Key observations and experiences
   - ✓ Answers to questions raised during the visit
8. Organize a session for trainees to present their reports to the class.
9. Facilitate a discussion to encourage sharing of insights and foster collaborative learning.

Formative Assessment

Section A: Multiple Choice Questions (Choose the correct answer)

1. **Before using a pH meter in the field, you should first:**

   A. Shake the meter

   B. Wash it with soap

   C. Calibrate it with buffer solution

   D. Store it in sunlight

2. **Which of the following is used to calibrate a pH meter?**

   A. Tap water

   B. Distilled water

   C. Saltwater

   D. Buffer solution

3. **Why should batteries be removed from equipment after use?**

   A. To save space

   B. To prevent battery leakage

   C. To make the equipment lighter

   D. To cool the equipment

4. **Which sensor must be stored with its tip in a wet solution?**

   A. Thermometer

   B. EC (conductivity) probe

   C. pH sensor

   D. Turbidity tube

5. **When storing sensors and cables, where is the best place to keep them?**

   A. In a hot room

   B. Under direct sunlight

   C. In a cool, dry place

   D. On a metal surface outside

Section B: Tick the Correct answer (✓)

6. **Tick (✓) the correct steps you should take before using water quality tools:**

   a) Inspect the tool for damage ✓

b) Wash the sensor with soap

c) Calibrate using clean solution✓

d) Store in warm water

e) Check battery level ✓

7. Tick ✓ the good storage practices below:

a) Keep sensors dry without caps

b) Remove batteries if storing for long ✓

c) Store solutions in open containers

d) Place sensors upright in container ✓

e) Use airtight storage when possible✓

Section C: Open-Ended Questions

8. List 3 things you must check before using water testing equipment.

Answers:

• Battery level is adequate.

• Sensor and cables are clean and undamaged.

• Calibration status and accuracy of the device.

9. Explain why calibration is important before testing water quality.

Answers:

• Ensures accurate and reliable readings.

• Compensates for sensor drift over time.

• Helps maintain data consistency for decision-making in fish farming.

10. Describe how you would store a pH sensor after use in the field.

Answers:

• Rinse the sensor tip with distilled water to remove residues.

• Place the probe tip in pH storage solution or buffer solution (never dry).

• Keep the sensor upright in an airtight container or protective case, stored in a cool, dry place.

Self-Reflection

1. Ask learners to re-take the self-assessment at the beginning of the unit. They should then fill in the table in their Trainee's Manual to Identify their areas of strength, areas for improvement and actions to take to improve.
2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Points to Remember

- Identify required water quality Tools and equipment: Know which tools are needed for specific parameters (e.g., DO meter, pH meter, thermometer, test kits). In addition, inspect them for Damage or Expiry and cleaning before use.
- Remember to calibrate water quality tools and equipment regularly especially before use with standard solution (use certified buffer solutions) and follow the accurate procedures.
- For storing, water quality tools and equipment have to be stored in clear, Dry Conditions to prevent moisture damage, corrosion, and bacterial growth.
- Maintain Battery and Probe Care: Remove batteries if not in use for long, and keep pH/DO probes moist in storage solution

Further Information for the Trainer

Make further research about preparation of water quality tools and equipment, calibration of tools and equipment, and storage of water quality tools, materials.

Reference

1. YSI Incorporated. (2019). Calibration guide for YSI water quality sondes and sensors. Yellow Springs Instruments.
2. GlobalSpec. (n.d.). Water quality measurement instruments. Retrieved July 21, 2025, from

https://www.globalspec.com/learnmore/sensors_transducers_detectors/environmental_sensors/water_quality_measurement_inst

3. YSI Incorporated. (2020). Best practices for storing YSI water quality sensors. Yellow Springs Instruments.
4. American Public Health Association. (2017). Standard methods for the examination of water and wastewater (23rd ed.). American Public Health Association, American Water Works Association, Water Environment Federation.

Learning outcome 2: Self-Assessment

1. Ask trainees to look at the unit illustration in their Trainee's Manuals and together discuss:

   What does the illustration show?

   What do you think will be topics to be covered under this unit based on the illustration?

2. After the discussion, inform students that this unit is intended to provide them with the knowledge, skills and attitudes to Assessing water quality. They will cover the skills required to taking water quality sampling to the laboratory, measurement of water quality parameter and recording water quality parameter readings.

3. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee's Manuals. Explain that:

   a. The purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning.

   b. There are no right or wrong ways to answer this assessment. It is for their own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.

   c. They should think about themselves: do they think they have the knowledge, skills or attitudes to do this? How well?

   d. They read the statements across the top and put a check in column that best represents their level of knowledge, skills or attitudes.

   e. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas of improvement and actions to be taken.

Key Competencies:

Knowledge	Skills	Attitudes
1. Identify tools, materials, and equipment used in water quality measuring/monitoring	1. Use of tools, materials and equipment for water quality measurement	1. Attention to Detail, responsibility, and carefulness
2. Explain the procedures for water sample collection	2. Collect water samples	2. Attention to detail while taking water samples
3. Identify water quality parameters	3. Measure water quality parameters	3. Accuracy and attention to detail
4. Explain water record-keeping methods	4. Record water quality	4. Accuracy and attention to detail while recording water quality parameters
5. Understand ideal water quality standards	5. Interpret water quality parameters	5. Critical thinking

Steps:

Task 11

Discovery activity

1. Using an appropriate methodology such as pair-share, large group discussion and presentation, the objective is to foster engagement and knowledge exchange among students.
2. Take students through the following steps:

a. Firstly, organize trainees into pairs or small groups and guide them through a structured discussion about questions on **task 11** in trainee's manual. Ensure active participation and understanding of instructions.

d. Secondly, bring the trainees back together as a large group for presentations. Each pair or group should summarize their discussions, sharing insights and learnings with the class. Encourage all trainees to contribute their own experiences and reflections.

e. Conclude the activity with feedback and reflection. Emphasize that the purpose was not to find right answers but to provide a look into trainees' scheduling of laundry roaster.

3. Introduce Topic 2.1: Taking water samples to the laboratory

Topic 2.1: Taking water samples to the laboratory

Objectives:

By the end of the topic, trainees will be able to:

a. Identify properly tools and materials used in water sampling

b. Prepare correctly plan for water sampling

c. Identify properly the procedures of water sample collection.

d. Take properly the water samples for analyse quality parameters

e. Delivery correctly the samples to the laboratory for testing

Time Required: 8 hours.

Learning Methodology:

Group discussion, brainstorming, presentation, Think-Pair-square-share, pair work, Individual work, demonstration, observation, role-play, field visit

Materials, Tools and Equipment Needed:

✓ Water sampling bottles, books, Pen, labels and Person Protective Equipment

Preparation:

- ❑ Read and understand the scenario before giving it to the students
- ❑ Gather in advance tools, materials, and equipment needed to deliver the session.
- ❑ Arrange a conducive learning environment

Cross Cutting Issues:

- ✓ **Gender balance:** Mix girls and boys in order to promote cross-gender interaction. Encourage both genders to take on roles of leadership
- ✓ **Inclusive education:** Ensure inclusivity while allocating tasks to students and provide facilities/environment that enable/allows participation of all

Prerequisites:

- Occupational health and safety procedures

Activity 1: Problem-Solving

Task 12

1. Using various methodologies like pair-share, or small group discussions, Instruct the trainees to join their respective groups and read the following scenario: GreenRiver Fish Farm operates five tilapia ponds. Over the past two days, the Manager noticed several dead fish floating in Pond 4 early in the morning. The water appeared slightly green and had a foul odor. Thus, the Manager decide to take water sample to laboratory.
2. Tell them to discuss and answer the following questions:
    1) Identify tools, materials, and equipment for water sampling.

2) What are the procedures for water sample collection?
3) Why is it necessary to transport the samples in a cooler and deliver them within a few hours?
4) What could happen if samples are mislabeled or exposed to sunlight for too long before reaching the lab?

- ✓ Allow 10 -15 minutes for discussion.
- ✓ Move around the classroom to check progress and provide clarification if any.
- ✓ Nominate or tell the group to nominate one speaker to share the findings of the group
- ✓ Give 2-3 minutes per group

3. After all groups present, thank them and then provide the correct responses:

1) The following are the tools, materials, and equipment for water sampling:
   - ➢ Tools: Sample bottles, Cooler box, Water sampler, Sampling pole, Pens and note books, Chest waders
   - ➢ Materials: Ice, Plastic bags, Acids, Labeling materials, Sample submission form, Gloves (disposable)
   - ➢ Equipment: Boat
2) The procedures for water sample collection are:
   - ➢ Aseptic technique
   - ➢ Contamination control
   - ➢ Sample drawing
   - ➢ Water sample fixation/preservation
   - ➢ Sample labelling and packaging
   - ➢ Sample storage
   - ➢ Sample submission form
3) It necessary to transport the samples in a cooler and deliver them within a few hours because, Samples must be kept cold using ice packs or insulation to prevent changes in water chemistry, especially for DO, ammonia, and microbial tests.

4) What could happen if samples are mislabeled or exposed to sunlight for too long before reaching the lab are as follow:
   - ➢ If samples are mislabeled, they lose identity and reliability, making results invalid, and
   - ➢ Exposing samples to sunlight raises temperature and alters water chemistry, affecting DO, ammonia, and microbial levels.
   - ➢ These issues compromise sample integrity and lead to inaccurate or misleading laboratory results.

4. Wrap up by Highlighting key points related to the scenario:
   - Identification of tools , materials, and equipment for water sampling

- Water sampling procedure
- Transport condition of water sampling

5. After the sharing session, let trainees to the Key facts 2.1 for further enhancement.

Activity 2: Guided Practice

Task 13

1. Using an appropriate methodology such as individual work, pair-share, small group work, guide trainees to carry out the activities provided under **task 13** in their Trainee's Manuals. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
2. During the task, trainees should be given a degree of independence to apply the knowledge and skills acquired in activity. Attend to each group, individual and provide support where necessary. Your role is to guide them by using probing questions such as Why? What? How? to enable them to come to informed responses.
3. While trainees are still performing the task, use this opportunity to discuss or address cross-cutting issues that may arise such as gender, inclusivity, financial education among others, even during group formation. Also attitudes and behavior changes should be handled during this activity.
4. Using an appropriate methodology such as question and answer in a large group, pair presentations or small group presentations, guide trainees to share their answers to the class. Write their responses for reference. Encourage all trainees to give their views.
5. After the sharing session, refer trainees to Key Facts 2.1, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have. Use the observation/performance checklist below while assessing the calibration of water quality tools and equipment

Indicator (Elements to be checked)	Observation		Marks allocation
	Yes	No	
Water samples were properly corrected from each pond and taken to the laboratory for analysis			
Water sampling procedures were properly followed			
Each container was clearly labeled with pond number, time and date of collection			
Water samples were handled carefully to avoid contamination			

Activity 3: Application

Task 14

1. Using an appropriate methodology such as individual work, pairs, or small groups, trainees will read the statement provided on **task 14** in the trainees' manual and perform the task. Ensure that all instructions are clear and understood by the trainees, and encourage active participation among all students. This activity requires students to work independently with limited support from the trainer.
2. Provide necessary materials and tools for the task to be completed effectively.
3. Let the trainees Identify suitable workplaces for them or identify workplace for them, which may include:
   - ✓ Locations within the school compound
   - ✓ Local farms
4. Encourage trainees to actively observe technicians as they perform their tasks.
5. Allow trainees to participate in hands-on activities whenever possible to gain practical experience.
6. Encourage trainees to ask as many questions as possible regarding:
   - ✓ The tasks being performed
   - ✓ Tools and equipment in use
   - ✓ Best practices and safety measures
7. After the visit, have each trainee write a report that includes:
   - ✓ An overview of the workplace
   - ✓ Key observations and experiences
   - ✓ Answers to questions raised during the visit
8. Organize a session for trainees to present their reports to the class.
9. Facilitate a discussion to encourage sharing of insights and foster collaborative learning.

Topic 2.2: Measurement of water quality parameters

Objectives:

By the end of the topic, trainees will be able to:

a. Identify properly water quality parameters in fish farming.

b. Explain correctly the technique of measuring and testing water quality parameters in fish farming.

c. Measure correctly the water quality parameters in fish farming.

Time Required: 20 hours.

Learning Methodology:

Group discussion, brainstorming, presentation, Think-Pair-square-share, pair work, Individual work, demonstration, observation, role-play, field visit

Materials, Tools and Equipment Needed:

✓ Dissolved Oxygen (DO) meter, pH meter, Thermometer / digital temperature probe, Conductivity meter / multi parameter probe, Turbidity meter (Secchi disk or digital), Multi parameter water quality meter, Colorimetric test kits, Titration kits, Test strips, Chemical reagents / indicators, labelled sample bottles, Cooler box with ice pack, Notebook or data sheets and Permanent marker.

Preparation:

❑ Read and understand the scenario before giving it to the students

❑ Gather in advance tools, materials, and equipment needed to deliver the session.

❑ Arrange a conducive learning environment

Cross Cutting Issues:

- ✓ **Gender balance:** Mix girls and boys in order to promote cross-gender interaction. Encourage both genders to take on roles of leadership.
- ✓ **Inclusive education:** Put trainees into different mixed-ability groups. If there are, trainees with disabilities mix them with others. If there are some with hearing disabilities or communication difficulties, you should always get their attention on before you begin to speak and encourage them to look at your face when you speak.
- ✓ **Critical thinking:** Give activities which enhance critical thinking
- ✓ **Communication:** Encourage every group member to participate in discussions and/or oral presentations

Prerequisites:

- Occupational health and safety procedures.

Activity 1: Problem-Solving

Task 15

1. Using various methodologies like pair-share, or small group discussions, Instruct the trainees to join their respective groups and read the following scenario:
   Mr. John is a field technician working with a cage-culture tilapia farm located in a freshwater reservoir at Bugesera District. The farm has reported unusual fish behavior in Cages: (1) Fish are gasping at the surface, (2) Feeding has dropped significantly, and (3) Some fish are showing red gills and slow movement. Therefore, He decide to collect water samples and bring them to the laboratory for measuring.
2. Tell them to discuss and answer the following questions:
   1) What are water quality parameters, and why are they important in fish farming?
   2) Which water quality parameters can cause the problem in the scenario?
   3) What are the techniques of measuring water quality parameters?

4) Identify procedures for measuring water quality parameters

- ✓ Allow 8-10 minutes for discussion.
- ✓ Move around the classroom to check progress and provide clarification if any.
- ✓ Nominate or tell the group to nominate one speaker to share the findings of the group
- ✓ Give 2-3 minutes per group

3. After all groups present, thank them and then provide the correct responses:

1) The following are water quality parameters:

- ➢ Water quality parameters are measurable factors such as dissolved oxygen, temperature, pH, ammonia, conductivity, turbidity, alkalinity, and hardness that determine the suitability of water for fish.
- ➢ They are important in fish farming because they affect fish health, growth, reproduction, and survival, and poor water quality can lead to stress, disease, or mortality.

2) The water quality parameters which can cause the problem in the scenario are:

- ➢ Low dissolved oxygen (DO)
- ➢ Extreme Temperature
- ➢ High ammonia levels
- ➢ High turbidity
- ➢ Low alkalinity

3) The techniques of measuring water quality parameters are:

- ➢ In-situ (using digital instruments/meters): DO meter, pH meter, thermometer, turbidity meter, conductivity meter, or multi parameter probe.
- ➢ Chemical measuring techniques: Colorimetric tests, titration methods (e.g., Winkler for DO, alkalinity, hardness), and test strips for quick checks.

4) The procedures for measuring water quality parameters are:

- ➢ Preparation
- ➢ Site Selection and Safety
- ➢ In-Situ Measurement Procedure (using meters)
- ➢ Chemical Testing Procedure (using test kits or titration)
- ➢ Record Keeping
- ➢ Interpretation and Action

Wrap up by Highlighting key points related to the scenario:

- Identification of water quality parameters and their effects in fish farming.
- Identification of techniques of measuring water quality parameters
- Identification of procedures for measuring water quality parameters

b. After the sharing session, let trainees to the Key facts 2.2 for further enhancement.

Activity 2: Guided Practice

Task 16

1. Using an appropriate methodology such as individual work, pair-share, small group work, guide trainees to carry out the activities provided under **task 16** in their Trainee's Manuals. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
2. During the task, trainees should be given a degree of independence to apply the knowledge and skills acquired in activity. Attend to each group, individual and provide support where necessary. Your role is to guide them by using probing questions such as Why? What? How? to enable them to come to informed responses.
3. While trainees are still performing the task, use this opportunity to discuss or address cross-cutting issues that may arise such as gender, inclusivity, financial education among others, even during group formation. Also attitudes and behavior changes should be handled during this activity.
4. Using an appropriate methodology such as question and answer in a large group, pair presentations or small group presentations, guide trainees to share their answers to the class. Write their responses for reference. Encourage all trainees to give their views.
5. After the sharing session, refer trainees to Key Facts 2.2, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have. Use the observation/performance checklist below while assessing the calibration of water quality tools and equipment

Indicator (Elements to be checked)	Observation		Marks allocation
	Yes	No	
Dissolved Oxygen (DO) is measured			
Temperature is measured			
ph is measured			
Ammonia is measured			
Turbidity is measured			

Alkalinity is measured			
Hardness is measured			

Activity 3: Application

Task 17

1. Using an appropriate methodology such as individual work, pairs, or small groups, trainees will read the statement provided on **task 17** in the trainees' manual and perform the task. Ensure that all instructions are clear and understood by the trainees, and encourage active participation among all students. This activity requires students to work independently with limited support from the trainer.
2. Provide necessary materials and tools for the task to be completed effectively.
3. Let the trainees Identify suitable workplaces for them or identify workplace for them, which may include:
   - ✓ Locations within the school compound
   - ✓ Local farms
4. Encourage trainees to actively observe technicians as they perform their tasks.
5. Allow trainees to participate in hands-on activities whenever possible to gain practical experience.
6. Encourage trainees to ask as many questions as possible regarding:
   - ✓ The tasks being performed
   - ✓ Tools and equipment in use
   - ✓ Best practices and safety measures
7. After the visit, have each trainee write a report that includes:
   - ✓ An overview of the workplace
   - ✓ Key observations and experiences
   - ✓ Answers to questions raised during the visit
8. Organize a session for trainees to present their reports to the class.
9. Facilitate a discussion to encourage sharing of insights and foster collaborative learning.

Topic 2.3: Recording of water quality parameter readings

Objectives:

By the end of the topic, trainees will be able to:

a. Differentiate properly methods of record keeping in water quality monitoring

b. Explain properly the replication of reading and its importance in water quality monitoring

c. Record properly water quality parameters readings

Time Required: 6 hours.

Learning Methodology:

Group discussion, brainstorming, presentation, Think-Pair-square-share, pair work, Individual work, demonstration, observation, role-play, field visit

Materials, Tools and Equipment Needed:

✓ Field notebooks, Standardised data sheets, Pens/ pencils, computers, smartphones or tablets, internet connection, power, calibrates water quality meters

Preparation:

- ❑ Read and understand the scenario before giving it to the students
- ❑ Gather in advance tools, materials, and equipment needed to deliver the session.
- ❑ Arrange a conducive learning environment

Cross Cutting Issues:

- ✓ **Gender balance:** Mix girls and boys in order to promote cross-gender interaction. Encourage both genders to take on roles of leadership.
- ✓ **Inclusive education:** Put trainees into different mixed-ability groups. If there are, trainees with disabilities mix them with others. If there are some with hearing disabilities or communication difficulties, you should always get their attention on before you begin to speak and encourage them to look at your face when you speak.
- ✓ **Critical thinking:** Give activities which enhance critical thinking
- ✓ **Communication:** Encourage every group member to participate in discussions and/or oral presentations

Prerequisites:

- Occupational health and safety procedures

Activity 1: Problem-Solving

Task 18

1. Using various methodologies like pair-share, or small group discussions, Instruct the trainees to join their respective groups and read the following scenario:
   A fish farm has been losing fish slowly over the past week. The Manager asks to see the water quality records, but the trainee, Mr. Eric, has only a few handwritten records. Some readings are missing dates, and some values are not clear and readable. Because of this, the Manager cannot tell when or where the problem started, and cannot explain the fish deaths.
2. Tell them to discuss and answer the following questions:
   1) What does it mean to record water quality parameter readings?

2) Why is it important to record water quality parameter readings regularly in aquaculture?
3) Why is it important to write the date, time, and location clearly when recording?
4) What tools or forms are used to record water quality data?
5) What method(s) of record keeping would you recommend to Mr. Eric in the futuer, and why?

- ✓ Allow 10-15 minutes for discussion.
- ✓ Move around the classroom to check progress and provide clarification if any.
- ✓ Nominate or tell the group to nominate one speaker to share the findings of the group
- ✓ Give 2-3 minutes per group

3. After all groups present, thank them and then provide the correct responses:

1) The record water quality parameter readings refers to process of measuring and Documenting the water parameter test results in a systematic way, either on paper or digitally, for future reference and decision-making
2) Importance of recording water quality parameter readings regularly in aquaculture is: to help track changes in the aquatic environment, detect harmful conditions early, and confirm whether water is suitable for fish growth, and provide reliable data for problem-solving, management decisions, and reporting.
3) Importance of writing the date, time, and location clearly when recording is because water quality changes with time and place, recording these details ensures data is traceable, comparable, and accurate. Without them, results may lose reliability and cannot be correctly interpreted or acted upon.
4) The tools or forms used to record water quality data are:

- ➢ Manual: Field notebooks, paper data sheets, clipboards, pens/pencils.
- ➢ Digital: Computers with Excel or Google Sheets.
- ➢ Mobile apps: AquaFarm Monitor, mWater, or other farm apps.
- ➢ Database systems: Microsoft Access or specialized aquaculture databases for large farms.

5) I would recommend digital spreadsheets or mobile apps because they reduce errors, automatically calculate averages, highlight dangerous values, and safely store data in computers or the cloud.

4. Wrap up by Highlighting key points related to the scenario:
    - Methods of record keeping
    - Identification of tools, materials and equipment for recording keeping
    - The importance of record keeping
5. After the sharing session, let trainees to the Key facts 2.3 for further enhancement.

Activity 2: Guided Practice

Task 19

1. Using an appropriate methodology such as individual work, pair-share, small group work, guide trainees to carry out the activities provided under **task 19** in their Trainee's Manuals. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
2. During the task, trainees should be given a degree of independence to apply the knowledge and skills acquired in activity. Attend to each group, individual and provide support where necessary. Your role is to guide them by using probing questions such as Why? What? How? to enable them to come to informed responses.
3. While trainees are still performing the task, use this opportunity to discuss or address cross-cutting issues that may arise such as gender, inclusivity, financial education among others, even during group formation. Also attitudes and behavior changes should be handled during this activity.
4. Using an appropriate methodology such as question and answer in a large group, pair presentations or small group presentations, guide trainees to share their answers to the class. Write their responses for reference. Encourage all trainees to give their views.
5. After the sharing session, refer trainees to Key Facts 2.3, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have. Use the observation/performance checklist below while assessing the calibration of water quality tools and equipment

Indicator (Elements to be checked)	Observation		Marks allocation
	Yes	No	
Date/time is recorded			
Pond/cage is recorded			
DO test result is recorded			
Temperature test result is recorded			
pH test result is recorded			
Turbidity test result is recorded			
General observations are recorded			
The technician name is recorded			
The form is signed by the technician			

Activity 3: Application

Task 20

1. Using an appropriate methodology such as individual work, pairs, or small groups, trainees will read the statement provided on **task 20** in the trainees' manual and perform the task. Ensure that all instructions are clear and understood by the trainees, and encourage active participation among all students. This activity requires students to work independently with limited support from the trainer.
2. Provide necessary materials and tools for the task to be completed effectively.
3. Let the trainees Identify suitable workplaces for them or identify workplace for them, which may include:
   - ✓ Locations within the school compound
   - ✓ Local farms
4. Encourage trainees to actively observe technicians as they perform their tasks.
5. Allow trainees to participate in hands-on activities whenever possible to gain practical experience.
6. Encourage trainees to ask as many questions as possible regarding:

- ✓ The tasks being performed
- ✓ Tools and equipment in use
- ✓ Best practices and safety measures

7. After the visit, have each trainee write a report that includes:
   - ✓ An overview of the workplace
   - ✓ Key observations and experiences
   - ✓ Answers to questions raised during the visit
8. Organize a session for trainees to present their reports to the class.
9. Facilitate a discussion to encourage sharing of insights and foster collaborative learning.

Topic 2.4: Interpretation of water quality parameters

Objectives:

By the end of the topic, trainees will be able to:

a. Identify properly water quality standards used in fish farming
b. Interpret properly water quality trends overtime in fish farming
c. Interpret properly water quality parameters results in fish farming.

Time Required: 6 hours.

Learning Methodology:

Group discussion, brainstorming, presentation, Think-Pair-square-share, pair work, Individual work, demonstration, observation, role-play, field visit

Materials, Tools and Equipment Needed:

- ✓ Field notebooks, Standardised data sheets, Pens/ pencils, computers, smartphones or tablets, internet connection, power, calibrated water quality meters, Water quality standards charts/tables (acceptable ranges for species), Calibration solutions (pH buffers, conductivity standards, DO calibration kits), Distilled/deionized water (for cleaning probes and sample preparation)

Preparation:

- ❑ Read and understand the scenario before giving it to the students
- ❑ Gather in advance tools, materials, and equipment needed to deliver the session.

Arrange a conducive learning environment

Cross Cutting Issues:

- ✓ **Gender balance:** Mix girls and boys in order to promote cross-gender interaction. Encourage both genders to take on roles of leadership.
- ✓ **Inclusive education:** Put trainees into different mixed-ability groups. If there are, trainees with disabilities mix them with others. If there are some with hearing disabilities or communication difficulties, you should always get their attention on before you begin to speak and encourage them to look at your face when you speak.
- ✓ **Critical thinking:** Give activities which enhance critical thinking
- ✓ **Communication:** Encourage every group member to participate in discussions and/or oral presentations

Prerequisites:

- Occupational health and safety procedures

Activity 1: Problem-Solving

Task 21

1. Using various methodologies like pair-share, or small group discussions, Instruct the trainees to join their respective groups and read the following scenario:
   RiverView Fish Farm raises tilapia in several earthen ponds. Over the past three days, the farm workers noticed unusual fish behavior in Pond 5—fish are gasping at the surface, feeding has decreased, and some fish appear sluggish. A technician, David, was sent to collect and interpret water quality data. He used his meter and strips to take triplicate readings at 7:00 AM, a time when water quality problems often show up.
   Here are the average results for Pond 5:

Parameter	Value	Normal Range for Tilapia
Dissolved Oxygen (DO)	2.8 mg/L	5.0 – 8.0 mg/L
Temperature	25.5 °C	24 – 30 °C
pH	6.2	6.5 – 8.5
Ammonia (NH_3)	1.3 mg/L	0 – 0.5 mg/L (safe range)
Turbidity	< 10 NTU	Low to Moderate (for tilapia)

2. Tell them to discuss and answer the following questions:

    1) Which two water quality parameters are clearly outside the safe range?
    2) Based on the DO level, explain why fish are gasping at the surface in the morning.
    3) What risks does a low pH (6.2) combined with high ammonia (1.3 mg/L) pose to the fish?
    4) Suggest three immediate actions the farm should take to improve water quality in Pond
    5) What time of day is best for monitoring DO, and why?

    - ✓ Allow 810-15 minutes for discussion.
    - ✓ Move around the classroom to check progress and provide clarification if any.
    - ✓ Nominate or tell the group to nominate one speaker to share the findings of the group
    - ✓ Give 2-3 minutes per group

3. After all groups present, thank them and then provide the correct responses:

    1) The two water quality parameters which are outside the safe range are: Dissolved Oxygen (DO) and Ammonia
    2) The following are the reasons of fish gasping at the surface in the morning:

    - ➢ In the morning, dissolved oxygen (DO) is usually lowest because plants and algae consume oxygen at night during respiration, while photosynthesis (which produces oxygen) only starts after sunrise. If DO drops below 3 mg/L, fish experience stress and may gasp at the surface where oxygen is slightly higher.

    3) The risks of combined low pH (6.2) with high ammonia (1.3 mg/L) pose to the fish are:

        - ➢ Increase ammonia toxicity and weaken fish,

- leading to poor health,
- stress, or mass mortality.

4) The three immediate actions the farm should take to improve water quality in Pond are:
   - Increase aeration (using aerators or water agitation) to raise dissolved oxygen levels.
   - Partial water exchange to dilute ammonia and balance pH.
   - Reduce or adjust feeding to minimize waste build up and lower ammonia production.
5) The best time of day for monitoring DO is early morning because oxygen levels are at their lowest after the night (when respiration dominates and photosynthesis stops). This helps detect critical oxygen shortages that threaten fish survival.

4. Wrap up by Highlighting key points related to the scenario:
   - Water quality parameters standards
   - Water quality parameters deviations
   - Interpretation water quality parameters results
5. After the sharing session, let trainees to the Key facts 2.4 for further enhancements

Activity 2: Guided Practice

Task 22

1. Using an appropriate methodology such as individual work, pair-share, small group work, guide trainees to carry out the activities provided under task 22 in their Trainee's Manuals. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
2. During the task, trainees should be given a degree of independence to apply the knowledge and skills acquired in activity. Attend to each group, individual and provide support where necessary. Your role is to guide them by using probing questions such as Why? What? How? to enable them to come to informed responses.

3. While trainees are still performing the task, use this opportunity to discuss or address cross-cutting issues that may arise such as gender, inclusivity, financial education among others, even during group formation. Also attitudes and behavior changes should be handled during this activity.
4. Using an appropriate methodology such as question and answer in a large group, pair presentations or small group presentations, guide trainees to share their answers to the class. Write their responses for reference. Encourage all trainees to give their views.
5. After the sharing session, refer trainees to Key Facts 2.4, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have. Use the observation/performance checklist below while assessing the calibration of water quality tools and equipment

Indicator (Elements to be checked)	Observation		Marks allocation
	Yes	No	
DO test result is interpreted			
pH test result is interpreted			
Temperature test result is interpreted			
Ammonia result is interpreted			
Turbidity test result is interpreted			
All the water quality parameters are linked to the Fish behaviors, watercolor and smell.			
The immediate actions are recommended			

Activity 3: Application

Task 23

1. Using an appropriate methodology such as individual work, pairs, or small groups, trainees will read the statement provided on **task 23** in the trainees' manual and perform the task. Ensure that all instructions are clear and understood by the trainees, and encourage active participation among all students. This activity requires students to work independently with limited support from the trainer.
2. Provide necessary materials and tools for the task to be completed effectively.
3. Let the trainees Identify suitable workplaces for them or identify workplace for them, which may include:
   - ✓ Locations within the school compound
   - ✓ Local farms
4. Encourage trainees to actively observe technicians as they perform their tasks.
5. Allow trainees to participate in hands-on activities whenever possible to gain practical experience.
6. Encourage trainees to ask as many questions as possible regarding:
   - ✓ The tasks being performed
   - ✓ Tools and equipment in use
   - ✓ Best practices and safety measures
7. After the visit, have each trainee write a report that includes:
   - ✓ An overview of the workplace
   - ✓ Key observations and experiences
   - ✓ Answers to questions raised during the visit
8. Organize a session for trainees to present their reports to the class.
9. Facilitate a discussion to encourage sharing of insights and foster collaborative learning.

Formative Assessment

I. Choose the best answer for each.

1. Which of the following is a clear sign of low dissolved oxygen in a fishpond?

A. Rapid fish growth

B. Fish gasping at the surface

C. Clear water

D. Low turbidity

2. What is the safe pH range for tilapia farming?

A. 5.5 – 6.5

B. 7.5 – 9.5

C. 6.5 – 8.5

D. 4.0 – 7.0

3. High levels of ammonia in fishponds are often caused by:

A. Underfeeding

B. Overstocking and poor waste management

C. High oxygen levels

D. Cold water temperature

4. At what time of day is it best to monitor dissolved oxygen in ponds?

A. Noon

B. 3:00 PM

C. 7:00 AM

D. 6:00 PM

II. Tick ✓ the statements that are true.

5. Tick the correct statements below:

A. High turbidity is ideal for tilapia.

B. Ammonia above 0.5 mg/L can be harmful to fish. ✓

C. Fish swimming abnormally may indicate poor water quality. ✓

D. Low pH improves oxygen levels in ponds.

6. Tick the correct causes of degraded water quality:

A. Overstocking of fish✓

B. Adding clean gravel to the pond

C. Overfeeding fish✓

D. Regular water exchange

7. Tick the water quality parameters that are measured using test kits or strips:

A. pH✓

B. Ammonia✓

C. Fish weight

D. Feeding rate

III. Open-Ended Questions

6. Explain why tilapia might start gasping at the surface in the early morning.

   Answers:

   When DO drops too low (e.g., 2 mg/L), tilapia become stressed and start gasping at the surface where oxygen exchange is highest.

7. Describe two possible effects of high ammonia on fish health.

   Answers:

   a) Gill damage and stress – Ammonia irritates fish gills, reducing their ability to absorb oxygen. This can cause suffocation and stress.
   b) Reduced growth and increased disease risk – High ammonia weakens immunity, slows growth, and makes fish more vulnerable to infections and poor survival.

8. Suggest three immediate actions a farmer can take if water quality results show low DO, high ammonia, and low pH.

   Answers:

   c) Increase aeration – Add or switch on aerators/paddle wheels to raise DO levels.
   d) Partial water exchange – Replace some pond water with fresh, clean water to dilute ammonia and balance pH.
   e) Reduce or stop feeding temporarily – Less feeding means less waste and lower ammonia production.

Self-Reflection

1. Ask learners to re-take the self-assessment at the beginning of the unit. They should then fill in the table in their Trainee's Manual to Identify their areas of strength, areas for improvement and actions to take to improve.
2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Points to Remember

- Always use clean, labelled containers to avoid contamination and Collect samples from different pond depths and locations (not just the surface).
- Transport samples quickly (preferably in a cooler) to prevent changes in water chemistry.
- Calibrate your meters regularly for accurate results.
- Take measurements at consistent times (e.g., 7:00 AM) to observe trends.
- Record readings immediately after testing to avoid errors or forgetting.
- Use records and trends to adjust pond management (aeration, feeding, water exchange).

Further Information for the Trainer

Make further research about taking water quality sampling to the laboratory, measurement of water quality parameter and recording water quality parameter readings,

Reference:

1. Food and Agriculture Organization. (2019). Water quality and fish health. FAO. https://www.fao.org/3/ca6746en/CA6746EN.pdf
2. Food and Agriculture Organization (FAO). (2019). Water quality and fish health. https://www.fao.org/3/ca6746en/CA6746EN.pdf
3. Food and Agriculture Organization of the United Nations. (2007). Water quality management and pollution control in aquaculture (FAO Fisheries and Aquaculture Technical Paper No. 471). FAO. https://www.fao.org/3/y5053e/y5053e00.htm

Learning outcome 3: Self-Assessment

1. Ask trainees to look at the unit illustration in their Trainee's Manuals and together discuss:

   What does the illustration show?

   What do you think will be topics to be covered under this unit based on the illustration?

2. After the discussion, inform students that this unit is intended to provide them with the knowledge, skills and attitudes to correct water parameter. They will cover the skills required to Identification of deviation from water quality standards, Implementation of corrective measures for water quality parameters deviation and preparation of water quality reports.

3. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee's Manuals. Explain that:

   a. The purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning.

   b. There are no right or wrong ways to answer this assessment. It is for their own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.

   c. They should think about themselves: do they think they have the knowledge, skills or attitudes to do this? How well?

   d. They read the statements across the top and put a check in column that best represents their level of knowledge, skills or attitudes.

   e. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas of improvement and actions to be taken.

Key Competencies:

Knowledge	Skills	Attitudes
1. Compare measured values to established standards	1. Identify deviations from water quality standards	1. Accuracy-Oriented and Responsibility
2. Recognize Causes of Parameter Deviations	2. Implement corrective measures for water quality parameter deviations	2. Attention to Detail, Responsibility and Accountability
3. Interpret report format	3. Prepare water quality reports	3. Attention to Detail and proactive

Steps:

Discovery activity

Task 24

4. Using an appropriate methodology such as pair-share, large group discussion and presentation, the objective is to foster engagement and knowledge exchange among students.
5. Take students through the following steps:
    a. Firstly, organize trainees into pairs or small groups and guide them through a structured discussion about questions on **task 24** in trainee's manual. Ensure active participation and understanding of instructions.
    b. Secondly, bring the trainees back together as a large group for presentations. Each pair or group should summarize their discussions, sharing insights and learnings

with the class. Encourage all trainees to contribute their own experiences and reflections.

c. Conclude the activity with feedback and reflection. Emphasize that the purpose was not to find right answers but to provide a look into trainees' scheduling of laundry roaster.

6. Introduce Topic 3.1: Identification of deviation from water quality standards

Topic 3.1: Identification of deviations from water quality standards

Objectives:

By the end of the topic, trainees will be able to:

a. Define properly the term deviations used in water quality standards

b. Identify correctly the signs of water quality deviation in fish farming

c. Interpret properly deviations of water quality standards in fish farming.

Time Required: 10 hours.

Learning Methodology:

Group discussion, brainstorming, presentation, Think-Pair-square-share, pair work, Individual work, demonstration, observation, role-play, field visit

Materials, Tools and Equipment Needed:

✓ pH meter, DO meter, ammonia test kit, Nitrite/Nitrate test kit, Turbidity meter, data recording sheets, Logbook, Aerators, water pumps, Generator, cooler box, sampling bottles , water monitoring template, PPE.

Preparation:

- ❑ Read and understand the scenario before giving it to the students
- ❑ Gather in advance tools, materials, and equipment needed to deliver the session.
- ❑ Arrange a conducive learning environment

Cross Cutting Issues:

- ✓ **Gender balance:** Mix girls and boys in order to promote cross-gender interaction. Encourage both genders to take on roles of leadership.
- ✓ **Inclusive education:** Put trainees into different mixed-ability groups. If there are, trainees with disabilities mix them with others. If there are some with hearing disabilities or communication difficulties, you should always get their attention on before you begin to speak and encourage them to look at your face when you speak.
- ✓ **Critical thinking:** Give activities which enhance critical thinking
- ✓ **Communication:** Encourage every group member to participate in discussions and/or oral presentations

Prerequisites:

- ▸ Occupational health and safety procedures

Activity 1: Problem-Solving

Task 25

1. Using various methodologies like pair-share, or small group discussions, Instruct the trainees to join their respective groups and read the following scenario:

At Lakeview Hatchery, a technician arrives early in the morning and discover that dozens of fish have died overnight.

Observations:

- Dead fish are floating near the pond edge.
- Survivors are lethargic and gathering near the inflow pipe.
- The pond was fertilized two days ago to boost plankton growth.
- Weather has been hot and cloudy for several days.

Water test results (6:30 AM):

Parameter	Measured Value	Ideal Range
DO	2.1 mg/L	>5.0 mg/L
pH	7.2	6.5–8.5
Ammonia	0.04 mg/L	<0.05 mg/L
Temperature	28°C	24–30°C

2. Tell them to discuss and answer the following questions:

1) What is the deviated water quality parameter deviated from required standards?
2) How could fertilization and cloudy weather contribute to this situation?
3) Why are fish gathering at the inflow pipe?
4) What are corrective actions to be taken to save the fish from dying situation?

- ✓ Allow 10-15 minutes for discussion.
- ✓ Move around the classroom to check progress and provide clarification if any.
- ✓ Nominate or tell the group to nominate one speaker to share the findings of the group
- ✓ Give 2-3 minutes per group

3. After all groups present, thank them and then provide the correct responses:

1) The deviated water quality parameter deviated from required standards is: Dissolved Oxygen and Ammonia
2) The fertilization and cloudy weather are contributed to this situation as follow: Fertilization adds nutrients (N, P) that increase algal/plankton growth. These algae consume oxygen at night and when they die, decomposition further reduces DO
3) The reason why fish gathering at the inflow pipe are:

- The inflow pipe brings in fresh, oxygenated water.
- Fish instinctively move toward areas with higher DO to survive.

4) The corrective actions to be taken to save the fish from dying situation are:

- Aerate the pond (pumps, or even manual splashing) to increase DO.
- Add fresh water from the inflow or other sources to dilute and oxygenate the pond.
- Stop further fertilization or feeding temporarily, as both consume more oxygen.

4. Wrap up by Highlighting key points related to the scenario:

- Identification of signs of deviation
- Linking fish behavior with deviation
- Recommend corrective measures

5. Introduce topic 3.1: Identification of deviations from water quality standards

Activity 2: Guided Practice

Task 26

1. Using an appropriate methodology such as individual work, pair-share, small group work, guide trainees to carry out the activities provided under **task 26** in their Trainee's Manuals. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
2. During the task, trainees should be given a degree of independence to apply the knowledge and skills acquired in activity. Attend to each group, individual and provide support where necessary. Your role is to guide them by using probing questions such as Why? What? How? to enable them to come to informed responses.
3. While trainees are still performing the task, use this opportunity to discuss or address cross-cutting issues that may arise such as gender, inclusivity, financial education among others, even during group formation. Also attitudes and behavior changes should be handled during this activity.

4. Using an appropriate methodology such as question and answer in a large group, pair presentations or small group presentations, guide trainees to share their answers to the class. Write their responses for reference. Encourage all trainees to give their views.
5. After the sharing session, refer trainees to Key Facts 3.1, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have. Use the observation/performance checklist below while assessing the calibration of water quality tools and equipment

Indicator (Elements to be checked)	Observation		Marks allocation
	Yes	No	
Changes in fish behavior are observed			
Changes in water physical are observed			
Monitoring and comparison with fish species limit or acceptable range is done			
Identification of deviation from water quality standards is done			

Activity 3: Application

Task 27

1. Using an appropriate methodology such as individual work, pairs, or small groups, trainees will read the statement provided on **task 27** in the trainees' manual and perform the task. Ensure that all instructions are clear and understood by the trainees, and encourage active participation among all students. This activity requires students to work independently with limited support from the trainer.
2. Provide necessary materials and tools for the task to be completed effectively.
3. Let the trainees Identify suitable workplaces for them or identify workplace for them, which may include:
   - ✓ Locations within the school compound
   - ✓ Local farms
4. Encourage trainees to actively observe technicians as they perform their tasks.

5. Allow trainees to participate in hands-on activities whenever possible to gain practical experience.
6. Encourage trainees to ask as many questions as possible regarding:
   - ✓ The tasks being performed
   - ✓ Tools and equipment in use
   - ✓ Best practices and safety measures
7. After the visit, have each trainee write a report that includes:
   - ✓ An overview of the workplace
   - ✓ Key observations and experiences
   - ✓ Answers to questions raised during the visit
8. Organize a session for trainees to present their reports to the class.
9. Facilitate a discussion to encourage sharing of insights and foster collaborative learning.

Topic 3.2: Implementation of corrective measures for water quality parameter deviations.

	**Objectives:** By the end of the topic, trainees will be able to: a. Identify properly the causes of deviations in water quality parameters. b. Identify appropriately corrective measures for water quality parameter deviations c. Implement appropriately corrective measures for water quality deviations
	**Time Required:** 10 hours.
	**Learning Methodology:** Group discussion, brainstorming, presentation, Think-Pair-square-share, pair work, Individual work, demonstration, observation, role-play, field visit
	**Materials, Tools and Equipment Needed:** pH meter, DO meter, ammonia test kit, Nitrite/Nitrate test kit, Turbidity meter, data recording sheets, Logbook, Aerators, water pumps, Generator, air blowers, conductivity meter, diffusers, buckets, containers, storage tanks for water samples, PPE.
	**Preparation:** Read and understand the scenario before giving it to the students Gather in advance tools, materials, and equipment needed to deliver the session. Arrange a conducive learning environment

Cross Cutting Issues:

- ✓ **Gender balance:** Mix girls and boys in order to promote cross-gender interaction. Encourage both genders to take on roles of leadership.
- ✓ **Inclusive education:** Put trainees into different mixed-ability groups. If there are, trainees with disabilities mix them with others. If there are some with hearing disabilities or communication difficulties, you should always get their attention on before you begin to speak and encourage them to look at your face when you speak.
- ✓ **Critical thinking:** Give activities which enhance critical thinking
- ✓ **Communication:** Encourage every group member to participate in discussions and/or oral presentations

Prerequisites:

- Occupational health and safety procedures

Activity 1: Problem-Solving

Task 28

1. Using various methodologies like pair-share, or small group discussions, Instruct the trainees to join their respective groups and read the following scenario:

You are assigned to monitor and manage Pond 5 at a small-scale tilapia farm during the peak of the dry season. Over the past few days, the following signs have been observed:

- Fish are gasping at the water surface early in the morning.
- The water appears greenish and murky.
- Fish show slow movement and reduced appetite.
- There is a noticeable smell of rot or fermentation near the pond.
- Farmers report that they recently increased feeding and added more fingerlings to the pond.

The following results are obtained from early morning water quality parameters measuring and testing:

Parameter	Measured Value	Ideal Range	Status
Dissolved Oxygen	2.8 mg/L	5.0 – 7.0 mg/L	Low
Ammonia (NH_3)	0.6 mg/L	< 0.05 mg/L	High
pH	8.5	6.5 – 8.0	Slightly high
Temperature	32°C	26 – 30°C	High

2. Tell them to discuss and answer the following questions:

1) Identify the signs that suggest water quality problems in Pond 5.
2) Which water quality parameters are outside the recommended range?
3) Based on the test results and observations, what are the most likely causes of these deviations?
4) What immediate corrective actions would you take to stabilize the water quality and reduce fish stress?

- ✓ Allow 10-12 minutes for discussion.
- ✓ Move around the classroom to check progress and provide clarification if any.
- ✓ Nominate or tell the group to nominate one speaker to share the findings of the group
- ✓ Give 2-3 minutes per group

3. After all groups present, thank them and then provide the correct responses:

1. The signs that suggest water quality problems in Pond 5 are as follow:

- Fish are gasping at the water surface early in the morning.
- The water appears greenish and murky.
- Fish show slow movement and reduced appetite.
- There is a noticeable smell of rot or fermentation near the pond.

2. The water quality parameters that are outside the recommended range?

- Dissolved Oxygen (DO): 2.8 mg/L - Low (ideal 5.0–7.0 mg/L)
- Ammonia (NH_3): 0.6 mg/L - High (ideal <0.05 mg/L)
- pH: 8.5 - Slightly high (ideal 6.5–8.0)
- Temperature: 32 °C - High (ideal 26–30 °C)

3. Based on the test results and observations, the most likely causes of these deviations are as follow:

- Overfeeding - uneaten feed + feces leads to decomposition consumes oxygen, releases ammonia and foul odors.
- Overstocking (more fingerlings added) - higher biological oxygen demand and more ammonia excretion.
- High temperature (32 °C) - lowers oxygen solubility and increases fish metabolism (more O_2 demand, more waste).
- High pH (8.5) + high temp - increases the toxic unionized ammonia (NH_3) fraction, worsening stress and mortalities.

4. The immediate corrective actions would be taken to stabilize the water quality and reduce fish stress are the following:

- Start emergency aeration continuously with focus on pre-dawn and night.
- Stop feeding for 24 – 28 hours; reduced rate only after parameters stabilize
- Partial water exchange; RELACE 20-30% clean, cooler, well – oxygenated water; keep inflow on to create circulation.
- Reduce stocking density; move to some fish to another pond to cut oxygen demand and ammonia loading.

4. Wrap up by Highlighting key points related to the scenario:

- Identify the signs of the deviation
- Identify cause of deviation
- Implement appropriately corrective measures

5. Introduce topic 3.2: Implementation of corrective measures for water quality parameter deviations

Activity 2: Guided Practice

Task 29

1. Using an appropriate methodology such as individual work, pair-share, small group work, guide trainees to carry out the activities provided under **task 29** in their Trainee's Manuals. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
2. During the task, trainees should be given a degree of independence to apply the knowledge and skills acquired in activity. Attend to each group, individual and provide

support where necessary. Your role is to guide them by using probing questions such as Why? What? How? to enable them to come to informed responses.

3. While trainees are still performing the task, use this opportunity to discuss or address cross-cutting issues that may arise such as gender, inclusivity, financial education among others, even during group formation. Also attitudes and behavior changes should be handled during this activity.
4. Using an appropriate methodology such as question and answer in a large group, pair presentations or small group presentations, guide trainees to share their answers to the class. Write their responses for reference. Encourage all trainees to give their views.
5. After the sharing session, refer trainees to Key Facts 3.2, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have. Use the observation/performance checklist below while assessing the calibration of water quality tools and equipment

Indicator (Elements to be checked)	Observation		Marks allocation
	Yes	No	
The causes of deviation are identified			
The signs of deviation are identified			
Feeding rate is reduced			
Uneaten feed are removed			
Water exchange is done			
Continuously aeration is done			

Activity 3: Application

Task 30

1. Using an appropriate methodology such as individual work, pairs, or small groups, trainees will read the statement provided on **task 30** in the trainees' manual and perform the task. Ensure that all instructions are clear and understood by the trainees, and encourage active participation among all students. This activity requires students to work independently with limited support from the trainer.
2. Provide necessary materials and tools for the task to be completed effectively.

3. Let the trainees Identify suitable workplaces for them or identify workplace for them, which may include:
   - ✓ Locations within the school compound
   - ✓ Local farms
4. Encourage trainees to actively observe technicians as they perform their tasks.
5. Allow trainees to participate in hands-on activities whenever possible to gain practical experience.
6. Encourage trainees to ask as many questions as possible regarding:
   - ✓ The tasks being performed
   - ✓ Tools and equipment in use
   - ✓ Best practices and safety measures
7. After the visit, have each trainee write a report that includes:
   - ✓ An overview of the workplace
   - ✓ Key observations and experiences
   - ✓ Answers to questions raised during the visit
8. Organize a session for trainees to present their reports to the class.
9. Facilitate a discussion to encourage sharing of insights and foster collaborative learning.

Topic 3.3: Preparation of water quality reports

Objectives:

By the end of the topic, trainees will be able to:

a. Discuss properly the role of water quality report the elements of water quality report
b. Identify properly the components of water quality report format.
c. Prepare correctly water quality report

Time Required: 10 hours.

Learning Methodology:

Group discussion, brainstorming, presentation, Think-Pair-square-share, pair work, Individual work, demonstration, observation, role-play, field visit

Materials, Tools and Equipment Needed:

Recorded date sheet, Logbook, Computer, not books, pens, pencil, printer, digital cameras, water quality report templet, and other office facilitation.

Preparation:

Read and understand the scenario before giving it to the students

Gather in advance tools, materials, and equipment needed to deliver the session.

Arrange a conducive learning environment

Cross Cutting Issues:

- ✓ **Gender balance:** Mix girls and boys in order to promote cross-gender interaction. Encourage both genders to take on roles of leadership.
- ✓ **Inclusive education:** Put trainees into different mixed-ability groups. If there are, trainees with disabilities mix them with others. If there are some with hearing disabilities or communication difficulties, you should always get their attention

on before you begin to speak and encourage them to look at your face when you speak.

- ✓ **Critical thinking:** Give activities which enhance critical thinking
- ✓ **Communication:** Encourage every group member to participate in discussions and/or oral presentations

Prerequisites:

- Occupational health and safety procedures

Activity 1: Problem-Solving

Task 31

1. Using various methodologies like pair-share, or small group discussions, Instruct the trainees to join their respective groups and read the following scenario:

You are a trainee technician at GreenFish Aquaculture Farm, responsible for monitoring Pond 2, which is used for tilapia grow-out. During your weekly monitoring (22–28 July 2025), you observed the following:

- Fish were observed gasping at the surface in the early morning.
- Feeding behavior was poor, and uneaten feed was seen at the pond bottom.
- The pond water appeared greenish and murky.
- Staff reported a bad smell near the pond on the 26th of July.

Water quality measurements were taken daily at 7:00 AM and summarized as follows:

Parameter	Unit	Measured Value	Ideal Range	Status
Dissolved Oxygen	mg/L	2.8	5.0–7.0	Low
Ammonia (NH_3)	mg/L	0.7	< 0.05	High
pH	-	8.4	6.5–8.0	Slightly High
Temperature	°C	30	25–30	Acceptable
Water Clarity	Cm	15	> 30	Low

2. Tell them to discuss and answer the following questions:
   1) What would be an appropriate title for this report?
   2) Who is responsible for the report?

3) What is the correct date range for this report?
4) Why is documenting the monitoring period important?
5) Which specific signs suggest a water quality problem?
6) Which parameters are out of the acceptable range?

- ✓ Allow 8-10 minutes for discussion.
- ✓ Move around the classroom to check progress and provide clarification if any.
- ✓ Nominate or tell the group to nominate one speaker to share the findings of the group
- ✓ Give 2-3 minutes per group

3. After all groups present, thank them and then provide the correct responses:

1) The appropriate title for this report is:
   - ➢ Water Quality Monitoring Report – Pond 2, GreenFish Aquaculture Farm (22–28 July 2025)
2) The responsible for the report is:
   - ➢ The trainee technician who conducted the monitoring (in this case, the trainee assigned to Pond 2).
3) The correct date range for this report is:
   - ➢ 22–28 July 2025
4) Documenting the monitoring period is very important for:
   - ➢ Track changes and trends in water quality over time.
   - ➢ Compare results across weeks, months, or seasons.
   - ➢ Provide evidence for audits, traceability, and farm records.
   - ➢ Identify when specific problems started or worsened.
5) Which specific signs suggest a water quality problem?
   - ➢ Fish gasping at the surface early in the morning
   - ➢ There is a noticeable smell of rot or fermentation near the pond.
   - ➢ Poor feeding behavior / uneaten feed at pond bottom
   - ➢ Greenish, murky water (algal bloom)
   - ➢ Bad smell near the pond (organic matter decay, possible ammonia or H_2S buildup)
6) The parameters that are out of the acceptable range are:

   Dissolved Oxygen (2.8 mg/L) → Low (ideal 5.0–7.0 mg/L)

   Ammonia (0.7 mg/L) → High (ideal <0.05 mg/L

   pH (8.4) → Slightly high (ideal 6.5–8.0)

   Water Clarity (15 cm) → Low (ideal >30 cm)

4. Wrap up by Highlighting key points related to the scenario:

- Identification of the element of water quality report format

- Importance of documenting the monitoring period in water report

5. Introduce topic 3.3: Preparation of water quality reports

Activity 2: Guided Practice

Task 32

1. Using an appropriate methodology such as individual work, pair-share, small group work, guide trainees to carry out the activities provided under task 32 in their Trainee's Manuals. Make sure instructions are understood, all the trainees are actively participating, and necessary materials/tools are provided and being used.
2. During the task, trainees should be given a degree of independence to apply the knowledge and skills acquired in activity. Attend to each group, individual and provide support where necessary. Your role is to guide them by using probing questions such as Why? What? How? to enable them to come to informed responses.
3. While trainees are still performing the task, use this opportunity to discuss or address cross-cutting issues that may arise such as gender, inclusivity, financial education among others, even during group formation. Also attitudes and behavior changes should be handled during this activity.
4. Using an appropriate methodology such as question and answer in a large group, pair presentations or small group presentations, guide trainees to share their answers to the class. Write their responses for reference. Encourage all trainees to give their views.
5. After the sharing session, refer trainees to Key Facts 3.3, and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have. Use the observation/performance checklist below while assessing the calibration of water quality tools and equipment

Indicator (Elements to be checked)	Observation		Marks allocation
	Yes	No	
The title of report is clearly presented			

The technician name is mentioned in the report			
The date is presented in the report			
Findings are well summarized			
Water quality parameter table with respective measured values are presented			
Interpretation of measure values is done			
Recommendations are given			
The report is signed.			

Activity 3: Application

Task 33

1. Using an appropriate methodology such as individual work, pairs, or small groups, trainees will read the statement provided on **task 33** in the trainees' manual and perform the task. Ensure that all instructions are clear and understood by the trainees, and encourage active participation among all students. This activity requires students to work independently with limited support from the trainer.
2. Provide necessary materials and tools for the task to be completed effectively.
3. Let the trainees Identify suitable workplaces for them or identify workplace for them, which may include:
   - ✓ Locations within the school compound
   - ✓ Local farms
4. Encourage trainees to actively observe technicians as they perform their tasks.
5. Allow trainees to participate in hands-on activities whenever possible to gain practical experience.
6. Encourage trainees to ask as many questions as possible regarding:
   - ✓ The tasks being performed
   - ✓ Tools and equipment in use
   - ✓ Best practices and safety measures
7. After the visit, have each trainee write a report that includes:

- ✓ An overview of the workplace
- ✓ Key observations and experiences
- ✓ Answers to questions raised during the visit

8. Organize a session for trainees to present their reports to the class.
9. Facilitate a discussion to encourage sharing of insights and foster collaborative learning.

Formative Assessment -

Section A: Multiple Choice Questions (1 mark each)

Choose the correct answer by circling A, B, C, or D.

1. **What does fish gasping at the surface in the early morning typically indicate?**

   A. High temperature
   B. Low dissolved oxygen
   C. Low pH
   D. Excessive feeding

2. **Which of the following is an acceptable range for ammonia (NH_3) in tilapia farming?**

   A. < 1.0 mg/L
   B. < 0.1 mg/L
   C. < 0.05 mg/L
   D. < 0.5 mg/L

3. **A pH reading of 8.6 in a fish pond is considered:**

   A. Too low
   B. Ideal
   C. Slightly high
   D. Extremely high

4. **What is a short-term corrective measure for low dissolved oxygen levels?**

   A. Add more feed
   B. Increase aeration
   C. Stop water exchange
   D. Raise water temperature

5. **Which of the following is not a component of a standard water quality report?**

   A. Fish feeding schedule
   B. Parameter table with measured values
   C. Graphical trend analysis
   D. Recommendations

Section B: Tick-the-Box Questions

6. **Which of the following signs suggest water quality deviation?**

1. Gasping fish ✓
2. Clear water with bubbles
3. Bad smell near pond ✓
4. Dead fish at the edge ✓
5. Fish jumping for food eagerly

7. Which are valid corrective measures for high ammonia levels?

1. Apply zeolite ✓
2. Add more feed
3. Flush part of pond water ✓
4. Reduce feeding ✓
5. Increase stocking density

8. What are the common causes of water quality deviation?

1. Overstocking ✓
2. Poor feeding practices ✓
3. Regular monitoring
4. Poor aeration ✓
5. Fertilization during rainy season ✓

Section C: Open-Ended Questions

9. Explain how poor feeding practices can lead to water quality problems in fish ponds.
Answer:

Overfeeding causes uneaten feed to settle at the bottom where it decomposes. This decomposition process releases harmful gases like ammonia and hydrogen sulfide while consuming oxygen, which reduces dissolved oxygen levels and creates toxic conditions that stress or harm the fish.

10. List two key reasons why preparing a well-organized water quality report is important for aquaculture farm management.
Answer:

To monitor and track changes in water quality trends over time, allowing early detection of problems.
To provide accurate information for making management decisions and applying corrective actions to protect fish health and farm productivity.

Self-Reflection

1. Ask learners to re-take the self-assessment at the beginning of the unit. They should then fill in the table in their Trainee's Manual to Identify their areas of strength, areas for improvement and actions to take to improve.
2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Points to Remember

- **Always monitor parameters (DO, pH, ammonia, temperature, clarity) on schedule. Skipping checks may lead to late detection of serious problems;**
- **Know the ideal ranges for each parameter before measuring. Compare your readings against these standards to judge water quality. Do not rely only on instruments observe fish behavior and water appearance;**
- **Signs like gasping, lethargy, poor feeding, bad odor, or murky water are early alarms;**
- **Apply suitable corrective measures (increase aeration, reduce feed, partial water exchange, apply lime/zeolite);**
- **Delay in action may cause fish stress, disease, or even mortality;**
- **Write clear water quality reports. A good report is essential for decision-making and accountability.**

Further Information for the Trainer

Make further research about taking water quality sampling to the laboratory, measurement of water quality parameter and recording water quality parameter readings,

Reference;

1. Food and Agriculture Organization of the United Nations (FAO). (2007). Water quality management and pollution control in aquaculture (FAO Fisheries and Aquaculture Technical Paper No. 471). https://www.fao.org/3/y5053e/y5053e00.htm
2. Boyd, C. E., & Tucker, C. S. (2012). Pond aquaculture water quality management. Springer Science & Business Media.
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Integrated assessment

Integrated situation

TWORORE AMAFI Cooperative has a fish farm located in BUGESERA District, the production has been decreased because of poor water quality in fish ponds and the manager of the farm calls you as competent fish farming technician to solve that problem of poor water quality. You are requested to perform the following tasks in 3 hours:

1. Selection of water quality tools and equipment
2. Preparation of water quality tools and equipment.
3. Assess Water Quality
4. Measurement of water quality parameters
5. Correct Water Quality Parameters

All materials, tools and equipment are available at the cooperative.

Resources

Tools	Secchi disk, Water sample bottles, Water quality test kit, Thermometer, Burette, Pipettes, Beakers, Erlenmeyer flask, Water quality standard for fish farming, Computer with MS package
Equipment	Multi parameter meter, Dissolved oxygen meter, pH meter, Colorimeter, Turbidity meter
Materials/Consumables	pH Buffer solution, Calibration standards, Cleaning solutions,Test strips(ammonia), water, soap, Gloves, Sodium thiosulphate, Manganese sulfate, Alkaline Iodide-Azide solution, Sulfuric acid, Starch solution, Data collection sheets/logs

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	
1. Prepare Tools and Equipment	**1.1** All necessary tools and equipment for water quality assessment are prepared, ensuring they are clean .	**Assessment indicator 1:** water quality tools and equipment are prepared			7
		Assessment indicator 2: water quality tools and equipment's are selected			7
	1.2 Tools and equipment are calibrated to ensure accuracy.	**Assessment indicator 3:** Calibration of tools and equipment are well done.			7
	1.3. Tools and materials are organized and stored in designated areas for easy access.	**Assessment indicator 4:** Water quality tools, materials and equipment are stored.			4
		Assessment indicator5: Water quality tools, materials and equipment are organized .			3

2. Assess water quality	**2.1** Water samples are taken for laboratory analysis following standard protocols to ensure sample integrity.	**Assessment indicator 1:** water samples are taken to the laboratory			7
		Assessment indicator 2: Procedure for water sample collection is followed			7
		Assessment indicator 3: Sample are delivered to the laboratory.			7
	2.2 Water quality parameters such as temperature, pH, dissolved oxygen, turbidity are measured to ensure suitable environment for fish	**Assessment indicator 4:** Water quality parameters are measured.			9
		Assessment indicator 5: Procedures for measuring water quality parameters are followed.			7

	2.3 Water quality parameters are read and recorded accurately to maintain reliable data.	**Assessment indicator 6:** water quality parameter readings are Recorded.			7
	2.4. Recorded water quality parameters are analyzed to identify trends and potential issues.	**Assessment indicator7:** Recorded water quality parameters are analyzed.			7
	2.5. Water quality parameters are interpreted in the context of optimal conditions for fish health and growth.	**Assessment indicator 8:** Water quality parameters are interpreted			7
3. Correct Water Quality Parameters	**3.1.** Any deviations from acceptable water quality standards are identified, and corrective actions are proposed.	**Assessment indicator 1:** Deviations from acceptable water quality standards are identified.			7
	3.2. Corrective measures are implemented to adjust water parameters as needed to maintain optimal conditions.	**Assessment indicator 2:** Corrective measures are implemented to adjust water parameters.			7

	3.3. A report summarizing water quality assessments, analyses, and actions taken is prepared and submitted for record-keeping and management review.	**Assessment indicator 3:** Water quality reports are prepared.			7
Total marks					**…….**
Percentage Weightage					**100%**
Minimum Passing line % (Aggregate):					**70%**

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2. GlobalSpec. (n.d.). Water quality measurement instruments. Retrieved July 21, 2025, from https://www.globalspec.com/learnmore/sensors_transducers_detectors/environmental_sensors/water_quality_measurement_inst
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4. YSI Incorporated. (2020). Best practices for storing YSI water quality sensors. Yellow Springs Instruments.
5. American Public Health Association, American Water Works Association, & Water Environment Federation. (2017). Standard methods for the examination of water and wastewater (23rd ed.). American Public Health Association.Food and Agriculture Organization. (2019). Water quality and fish health. FAO. https://www.fao.org/3/ca6746en/CA6746EN.pdf
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11. Boyd, C. E., & Tucker, C. S. (2012). Pond aquaculture water quality management. Springer Science & Business Media.
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