Jockey Club STEAM Education Resources Sharing Scheme

Water You Know

Teachers' Guide

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Contents

1. Introduction

Jockey Club STEAM Education Resources Sharing Scheme is a 4-year project (2019-2023) funded by The Hong Kong Jockey Club Charities Trust and operated by the School of Science and Technology, Hong Kong Metropolitan University.

Traditionally, knowledge is transferred to students through a teacher-centred approach. Teachers teach students based on a subject-based curriculum that aims at content acquisition. However, little attention is given to how students learn and apply the knowledge to tackle matters in and beyond classrooms. Moreover, the knowledge domains are covered in terms of individual subjects, such as Physics, Biology, Chemistry, and Mathematics. Students learn individual subjects separately without holistic integration. As a result, students may not be sufficiently equipped to solve authentic problems in the real world.

"While Hong Kong students perform well in science, technology and mathematics, they may focus on disciplinary studies and may not evenly participate in hands-on activities in schools. Therefore, it is necessary to strengthen the ability of students to integrate and apply their knowledge and skills across different subject disciplines through solving daily life problems with practical solutions and innovative designs." (Curriculum Development Council, 2015).

Under this Scheme, the operational team will create a set of STEAM modules for secondary schools to strengthen students' ability to integrate and apply their knowledge and skills across different subject disciplines with a special focus on the use of innovative teaching pedagogies for STEAM education, i.e.

Science
Technology
Engineering
Arts
Mathematics

At least 20 modules would be developed to target students of average ability in solving authentic problems in daily life. Each module would provide 4 to 40 contact hours of student activities. In addition, students would do preparation or follow-up activities during non-contact hours. The ratio between contact hours and non-contact hours is approximately 1:1.

This document provides a detailed module plan for learning, teaching and assessment activities. The module will provide an opportunity for students to learn STEAM through hands-on and minds-on activities that integrates knowledge and skills across Science, Technology, Engineering, Arts and Mathematics under real-world contexts.

2. Module Outline

2.1 Module Title: Water You Know

As we all know, water is vital to all life forms. Rivers and streams were once the source of drinkable freshwater as well as providing an enjoyable aesthetic value to Hong Kong people in the early- to mid-1900s. However, with increasing pollution and human manipulation throughout the years, we can no longer take it for granted. After all, it is we who live in the neighbourhood of rivers and will probably suffer from direct or indirect adverse consequences caused by factoras such as stink, toxins, growth of disease-causing bacteria, and massive death of marine life, etc. which deteriorate our quality of life.

It is high time that students gain knowledge about water quality assessment in rivers in order to raise their awareness of the importance of environmental protection and ecological conservation. By conducting tests on the parameters of water quality and learning how to manipulate the equipment used for measurements, students are equipped to become citizen scientists to assess and compare the water quality of sampling sites in study models. (P.S. Shing Mum River is the study model in this module.)

Some knowledge covered by senior secondary Biology syllabi, for instance, abiotic factors of an ecosystem, water pollution control, algal bloom, and growth of microorganisms. What's more, knowledge and skills beyond the syllabus are included but not limited to Water Quality Objectives (WQOs) and Water Quality Index (WQI) for river waters of Hong Kong, inter-departmental work for monitoring and controlling water quality in Hong Kong, chemical and microbiological tests for water quality, data analysis and graph plotting and presentation skills using MS excel, accounting for measurement error and reliability of data.

2.2 Participants Recommended for this Module

- ☐ Junior Secondary School Students (please specify : _____)
- ☑ Senior Secondary School Students (please specify : S4-6)
- ☑ Others (please specify: students who are interested in exploring environmental science, ecology and microbiology as future studies/ career)

2.3 Module Aims

The module "Water You Know" aims to:

- *Introduce* students to the basic knowledge and techniques of water quality assessment
- *Introduce* and *build* equipment for the tests of parameters of water quality
- *Conduct* field studies and microscopic examination of water samples
- *Equip* students with data analysis and presentation skills

2.4 Module Learning Outcomes

Upon the completion of the module, students should be able to:

- *Understand* the parameters of water quality and *outline* the test in water *quality assessment*
- *Make* Do-It-Yourself (DIY) equipment to be utilized in field studies
- *Manipulate* the equipment to obtain data in the field site via field studies, *describe* and *analyse* data in order to assess water quality
- *Conduct* 5- or 10-minute presentations of their findings

2.5 Learning & Teaching Approach / Practice

The module adopts an activity-based learning approach: via field studies and DIY equipment sessions, the knowledge and techniques in water quality assessment and the working principles of equipment are delivered to students respectively. They become the true owners of knowledge and skills as they take active and dominant roles in the learning process.

Teachers and students are suggested to address the issue of water quality in rivers in Hong Kong scientifically by carrying out an investigative study. In general, an investigative study involves 5 stages:

(1) Asking questions and identifying relevant information;
(2) Planning an investigation (involving the choice of equipment and resources);
(3) Carrying out investigations;
(4) Organizing, analysing and interpreting data; drawing conclusions based on evidence;
(5) Presenting the findings.

With the aid of the student activity book, in which the guidelines for investigative study, datasheets for data recording, and guided questions can be found. The learning portfolios of individual students are built up. Moreover, evidence-based presentations are conducted by students so that can share their findings with others confidently.

At the end of the module, not only does the understanding of STEAM-related subject matter increase but also students' skills in design-thinking, communication, collaboration, critical thinking, and presentation are nurtured. Experience in

investigative study lays a foundation for independent investigations of virtually all topics in the future.

2.6 Nature of STEAM Activity

Element	Description	Composition
Science	Recognize the parameters in water quality and factors affecting water quality, field study principles and techniques, chemical tests for water quality, microscopic examination	✪✪✪✪
Technology	Measure and record data using laboratory equipment, IOT knowledge about data collection, use MS Excel to plot graphs	✪✪✪
Engineering	Make DIY equipment according to their working principles	✪✪
Arts	Address and raise concerns about the water quality in Shing Mun River	✪
Mathematics	Understanding the exponential function and logarithm to study bacteria undergoing binary fission, counting and estimation of the density of cells, standard deviation and standard error of the mean	✪✪✪

2.7 Mapping of Key Learning Areas (KLAs)

Unit	Science Education	Technology Education	Mathematics Education	Arts Education	Others *(please specify)*
1	Water conservation and pollution (SJ2.5) Water pollution control/sewage treatment (SB6.2) Abiotic factors of an ecosystem (SB3.6) Eutrophication and algal bloom (SB6.4)			Humanity: Address and raise concerns about the water quality in Shing Mun River and Hong Kong waters	
2	Measurement of abiotic factors (SB3.6)	Appropriate choice and use of tools for the realisation of design			Engineering: DIY from raw materials

Unit	Science Education	Technology Education	Mathematics Education	Arts Education	Others *(please specify)*
		solution (TK5.6)			
3	Measurement of abiotic factors (SB3.6) Study of a local habitat (SB3.6) Growth of microorganisms (bacteria and phytoplankton) (SB7.1) Aseptic techniques (SB7.1)	Choice, use and care of tools equipment (TK5.2) Working attitude (TK5.3) Safety measures within the working environment (TK5.4)	Solve exponential equations and logarithmic equations (MS3.5)		
4	Aseptic techniques (SB7.1) Cell counts (SB7.1) Chemical tests for nitrate and phosphate Gram staining Laboratory apparatus (compound microscope, auto-pipette) (SJ1.4)	Choice, use and care of tools equipment and chemicals (TK5.2) Safety measures within the working environment (TK5.4) Spreadsheet features (MS Excel- cell references, simple functions, basic mathematical operators, formatting features, error values, charts with two or more sets of data) (TK16.3)	Recognise the concept of errors in measurement (MJ15.1) Interpret statistical charts representing two different sets of data in daily life (MJ29.3) Choose appropriate statistical charts to present data (MJ29.6) Understand the concepts of mean (MJ30.1) Calculate mean (MJ30.2) The concept and properties	Statistical literacy: mean, SD, SEM, correlation coefficient Appreciate the beauty of the microscopic world	

Unit	Science Education	Technology Education	Mathematics Education	Arts Education	Others *(please specify)*
			of the normal distribution (MSA16.2) Understand the concept of standard deviation for data sets (MS17.4)		

Remark: Mapping the skill sets in this module with the respective KLAs in the school curriculum that would be covered.

2.8 Module Structure

Units		Contact Hours
1	Parameters of Water Quality Assessment	2 hr.
2	Making DIY Equipment for Field Studies	1 hr. 35 min.
3	Field Studies on Water Quality	4 hr. 30 min.
4	Microscopic Examination and Graphical Presentation of Data	6 hr. 20 min.
	Total	**14 hr. 25 min.**

*Remark: A total of **ONE** non-contact hour of the module is recommended.*

2.9 Thematic Area

- ☐ Computing and Information Technology
- ☐ Engineering
- ☐ Mathematics and Statistics
- ☑ Testing and Certification
- ☑ Environmental Safety and Sustainability

3. Module Design

This module consists of four units, accompanied by a teacher's guide, a student workbook, PowerPoint slides for teaching, an identification key for phytoplankton found in Hong Kong waters and some videos about the functions used in MS Excel. At the beginning of this module, to arouse their interest, students will be introduced to the background information about Shing Mun River and the news about the water quality of the river in Unit 1. More importantly, students will learn about the parameters of water quality so as to yield relevant investigative topics and set up the scaffold of a field trip.

Followed by Unit 2 in which students will be invited to make yet simple but workable DIY equipment such as plankton nets and Secchi discs. These experiences would create a sense of ownership for their field study in Unit 3. Furthermore, with the working principles of DIY and lab equipment explained, the applications of the equipment are useful and meaningful.

When it comes to Units 3 and 4, not only hands-on experience of field studies is gained, students will get a taste of microscopic examination by which bacteria and phytoplankton will be visualized. Students will learn the techniques in Gram staining and bacterial culturing via hands-on lab work.

To wrap things up, students will be guided to analyse the data collected scientifically and statistically, with the reliability and validity of data being taken into consideration. Each group of students will present their findings in 5 or 10 minutes.

In fact, other assessable rivers and streams in Hong Kong other than Shing Mun River are also suitable to be the study model for water quality assessment, e.g., Nam Sang Wai and Ma Wan.

3.1 Unit 1: Parameters of Water Quality Assessment

When rain falls over and drains from the highland to lower ground, salts, inorganic and organic compounds, and solid wastes are picked by water flows and eventually become a part of streams and rivers. Together with the biological processes carried out by bacteria and/or microalgae (phytoplankton), the water quality of these water bodies may change unexpectedly.

In order to address the problem of water quality squarely and honestly, in this unit we choose Shing Mun River as the study model and introduce to students the parameters of the water quality assessment. Physical and chemical parameters include water temperature, pH, conductivity, salinity, turbidity, nitrate and phosphate content, and dissolved oxygen, while biological parameters include E. coli (bacteria) content and phytoplankton content.

With the understanding of parameters, students can then form groups and relevant feasible investigative topics are yielded from their discussions with teachers. This paves the road for conducting field studies and presentations in Units 3 and 4.

3.1.1 Objective

Upon completion of *Unit 1*, students should be able to:

- *Understand* the basic knowledge of water quality assessment and the parameters of water quality
- *Outline* the parameters of the water quality assessment
- *Recognize* the effects of algal bloom and growth of microorganisms on water quality

3.1.2 Pre-requisite (if appropriate)

N/A

3.1.3 Description of Activity

Description	Duration (hr/min)	Resources
(1) Introduction ◆ The teacher assesses students' prior knowledge ◆ The teacher explains the learning objectives of this session	5 min.	
(2) Background information about water and its pollution ◆ The teacher addresses the current situation of Shing Mum River (SMR) and water pollution ◆ The teacher displays the calculation method of the Water Quality Index (WQI) and water quality goals (WQOs) for river waters of Hong Kong ◆ The teacher introduces stages in the investigative study with photos and maps and suggests the Shing Mun River (SMR) as the study model in this module ** EPD: Environmental Protection Department, HKSAR*	25 min.	◆ Game ◆ PPT (Unit 1) ◆ Student workbook
(3) Parameters in water quality ◆ Students explore the physical and chemical parameters of water quality—water temperature, pH, conductivity, salinity, turbidity, nitrate and phosphate content, dissolved oxygen, and their relevant tests ◆ Students explore the biological parameters of water quality- E. coli (bacteria) content and phytoplankton/microalgae content, and the relevant laboratory examination methods ◆ The teacher explains the concept of biological oxygen demand, bio-indicators of water pollution, adverse effects of massive bacterial growth and algal bloom	60 min.	◆ PPT (Unit 1) ◆ Student workbook ◆ Teacher's guide

Description	Duration (hr/min)	Resources
(4) Determining the topics for investigative study ◆ The teacher introduces investigative study to students and the steps involved ◆ Students form groups of 4-5 (students of mixed ability is preferred)^ ◆ The teacher suggests some feasible topics for investigative study from which students may choose if they are interested. Otherwise, students are guided by their teacher to draft their own topics ◆ Students discuss among themselves and with their teacher's advice, they come up with their group topics *^ According to EDB: Guidelines on Outdoor Activities, Because in field studies, students usually work in an extensive area that may make it difficult for the teacher to directly supervise them, thus grouping of students in at least 3 persons in a group and assigning 1 of them as the group leader are suggested.*	20 min.	◆ PPT (Unit 1) ◆ Student workbook ◆ Teacher's guide
(5) Debriefing ◆ The teacher reviews the knowledge covered in this session ◆ The teacher briefly introduces the next session	10 min.	◆ Student workbook
Total	**2 hr.**	

3.1.4 Assessment

- Students' participation in the discussion of the topics for the investigative study will be reviewed
- Students' acquirement of knowledge covered in this module would be assessed through the student worksheet with MCQs and short questions

3.2 Unit 2: Making DIY Equipment for Field Studies

Appropriate equipment and apparatus are necessary for successful sampling and measurements of parameters of water quality. However, some pieces of laboratory equipment for water quality assessment are not on the *EDB reference list of furniture and equipment (F&E) for secondary schools*. Thus, they may not be available in secondary schools due to their high costs.

Making equipment from raw materials (i.e. Do-It-Yourself (DIY)) is cost-effective and simple, especially meaningful when students understand their working principles, apply design-thinking skills and make them for their field studies in Unit 3. In this unit, we are going to make plankton nets and Secchi discs, in order to use them for capturing phytoplankton and measuring the turbidity of water respectively.

3.2.1 Objectives

Upon completion of *Unit 2*, students should be able to:

- *Understand* the working principles of plankton net and Secchi disc
- *Make* Do-It-Yourself (DIY) equipment for field study on water quality

3.2.2 Pre-requisite (if appropriate)

N/A

3.2.3 Description of Activity

Description	Duration (hr/min)	Resources
(1) Introduction ◆ The teacher recaps major ideas from the previous session ◆ The teacher assesses students' prior knowledge ◆ The teacher explains the learning objectives of this session	10 min.	
(2) Make Do-It-Yourself (DIY) equipment (plankton net and Secchi disc) for field study ◆ The teacher showcases some equipment and apparatus commonly used in water quality measurement It is suggested to do the following one by one for each piece of equipment: ◆ The teacher describes the working principles of the equipment ◆ The teacher demonstrates how to make the equipment ◆ Time is allowed for students to make their own equipment for their groups ** Approx. time required: plankton net (40 min.) and Secchi disc (20 min.)*	depends on the type of equipment made* 60 min. (maximum)	◆ PPT (Unit 2) ◆ Student workbook ◆ Teacher's guide ◆ Raw materials for making DIY equipment
(3) Announcement for field trips ◆ The teacher provides some information about the 2 field sites in SMR ◆ Student groups come up with their own investigative topics ◆ The teacher briefs on the arrangement and the rundown of field trips (date & time, assembly venue, dress code, personal protective equipment, transportation, etc.) ◆ The teacher collects the personal contact and emergency contact of students	25 min.	
Total	**35 min. (excl. (2))/**	

Description	Duration (hr/min)	Resources
	1 hr. 35 min. (maximum)	

3.2.4 Assessment

- Students' ability to describe the working principles of the equipment would be assessed
- Success in making equipment and their quality would be noticed
- Overall students' participation would be reviewed

3.3 Unit 3: Field Studies on Water Quality

In this unit, with the correct way of manipulation of laboratory equipment learnt, students are enabled to be citizen scientists to investigate the water quality of Shing Mun River. In a half-day field study at two selected field sites in SMR, students will gain hands-on experience in measuring the parameters of water quality on-site. Furthermore, water samples will be collected for further scientific analysis in the laboratories in Unit 4.

Students are encouraged to communicate with each other in their groups in order to accomplish the tasks. Besides, collaborative efforts by uploading field data for sharing among groups can enhance the reliability of data. Not only providing other learning experiences (OLE) to students, field studies help to arouse students' awareness of the ecological problems and water pollution found in the city where they are living in.

3.3.1 Objectives

Upon completion of *Unit 3*, students should be able to:

- *Conduct* tests on the parameters of water quality and *collect* water samples
- *Select* appropriate equipment tools and *manipulate* them correctly
- *Collect* and *record* field data in a comprehensive and a systematic way

3.3.2 Pre-requisite (if appropriate)

N/A

3.3.3 Description of Activity

Description	Duration (hr/min)	Resources
(1) Briefing ◆ The teacher recaps major ideas from the previous sessions ◆ The teacher assesses students' prior knowledge	40 min.	◆ Videos ◆ Student workbook ◆ Manual A

Description	Duration (hr/min)	Resources
◆ The teacher explains the learning objectives of this session ◆ The teacher demonstrates how to use the equipment tools (Van Dorn water sampler, Horiba water quality checker, plankton net, Secchi disc)* * As a more silent place than outdoors, HKMU is a more preferable place for this demonstration to take place. However, if the teacher prefers to gather students at the assembly venue instead of at HKMU, this demonstration can be in the form of videos that the teacher and students should have watched prior to the field work.		
(2) Fieldwork ◆ The teacher provides an on-site safety briefing and students are acknowledged of the position of first aid box[#] ◆ The teacher and facilitators (teaching assistants/lab technicians) supervise and assist students' field work^ ◆ At field site 1, students work in groups and conduct various measurements and record the data in the student workbook ◆ Students take water samples for laboratory work in the next session ◆ All participants travel to field site 2[@] ◆ At field site 2, repeat what has been done at field site 1 [#] *According to EDB: Guidelines on Outdoor Activities, before heading to field studies, teachers or facilitators should check if everything is ready in the first aid box and refill it if needed. The position of the first aid box should be announced to all participants along the way.* *^According to EDB: Guidelines on Outdoor Activities, field studies of students must be under the supervision of at least 2 teachers or facilitators. In general, the suggested ratio of teachers/facilitators to students is 1:18.* [@] *According to EDB: Guidelines on Outdoor Activities, teachers/facilitators should do head counts before setting out, during field studies, before proceeding to the next site and before the end of field studies respectively.*	3 hr.	◆ PPT (Unit 3) ◆ Student workbook ◆ Teacher's guide
(3) Post-field trip lab work ◆ All participants head to HKMU ◆ Students learn about the basic maintenance of equipment and tools by cleaning them up under the teacher's guidance ◆ To centralize and share the data among groups, students are required to input their group data to the Google Sheet form[#] ◆ Cultivation of bacteria* ◆ Incubation of *E. Coli** ◆ Teacher briefly introduces the next session	20 min. **(excl. (*))/ 50 min. (maximum)**	◆ PPT (Unit 3) ◆ Student workbook ◆ Google excel form ◆ Manual D

Description	Duration (hr/min)	Resources
** Approx. time required: Cultivation of bacteria (15 min.) and incubation of E. Coli (15 min.), instead by students, this can be done by lab technician.*		
Total	**4 hr (excl. * in (3)) / 4 hr 30 min. (maximum)**	

*Remark: (#) Around **0.5** non-contact hours are expected (for data entry and data checking)*

3.3.4 Assessment

- Students' ability to describe the working principles of the equipment would be assessed
- Success in measuring and recording data, and success in taking water samples in both field sites 1 and 2 would be noticed
- Students' skills in cultivation of bacteria and incubation of *E. Coli* would be assessed
- Overall students' participation in field study would be reviewed

3.4 Unit 4: Microscopic Examination and Graphical Presentation of Data

In this unit, a series of practical skills concerning water quality assessment are introduced to students including the preparation of temporary slides of phytoplankton, staining (Gram staining) and counting of bacteria and phytoplankton, observation of bacteria and phytoplankton using compound microscope, etc. Students may have a taste of laboratory-based tests.

Moreover, students are equipped with the skills of graph drawing using computers when they are guided to draw bar charts and scatter plots in MS Excel. To be critical thinkers, students should address measurement errors of the parameters as well as the reliability and validity of data. This can be done by using special functions in MS Excel to assess the relationship between parameters and to calculate the standard deviation (SD) and standard error of the mean (SEM).

The ultimate goal of this unit is to evaluate the water quality of Shing Mun River based on evidence and data analysis, we expect to see students being confident in presenting and sharing their findings in their 5- or 10-minute presentations.

3.4.1 Objectives

Upon completion of *Unit 4*, students should be able to:

- *Prepare* temporary mounts and conduct microscopic examinations of phytoplankton and *E. Coli*
- *Describe* and *analyse* data using MS Excel graphs and functions
- *Account for* measurement errors, reliability and validity of data
- *Conduct* 5- or 10-minute presentations of their findings

3.4.2 Pre-requisite (if appropriate)

N/A

3.4.3 Description of Activity

Description	Duration (hr/min)	Resources
(1) Introduction ◆ The teacher recaps major ideas/practices of the previous sessions ◆ The teacher assesses students' prior knowledge ◆ The teacher explains the learning objectives of this session	10 min.	
(2) Microscopic examination- phytoplankton ◆ The teacher guides students to prepare temporary mounts of phytoplankton ◆ The teacher guides students to use compound microscopes ◆ The teacher delivers some basic information about planktons, especially on the morphologies of phytoplankton ◆ Students identify the species of phytoplankton (info: AFCD website) and take photos of phytoplankton via objectives of microscopes	40 min.	◆ PPT (Unit 4) ◆ Student workbook ◆ Teacher's guide ◆ Identification key of phytoplankton found in Hong Kong waters ◆ Manual B ◆ Manual C
(3) Principle and skills in handling bacteria ◆ Students are guided to Gram stain bacteria in water samples ◆ Students observe bacteria under compound microscopes ◆ The teacher demonstrates how to prepare Petrifilm *E. coli.* / coliform count plate (skip this if the incubation of *E. Coli* in Unit 3 was already done by students) ◆ Students are taught how to count the number of colonies of *E. coli* and coliform bacteria on the prepared plates	40 min.	◆ PPT (Unit 4) ◆ Student workbook ◆ Teacher's guide ◆ Manual D
(4) Chemical tests for waste contents ◆ The teacher briefs the procedures of the tests for nitrate (or ammonia) and phosphate in water samples ◆ Students conduct the test for nitrate (or ammonia) ◆ Students conduct the test for phosphate (Alternative: Students apply chemical tests to find out the concentration of ammonia and phosphate in water samples)	55 min.	◆ PPT (Unit 4) ◆ Student workbook ◆ Teacher's guide ◆ Manual D

Description	Duration (hr/min)	Resources
◆ Students are required to input their group data in (3) and (4) to the Google Sheet form		
(5) Understanding measurement errors, reliability and validity of test methods ◆ The teacher accounts for measurement errors by introducing the concepts of mean, variance, standard deviation (SD), and standard error of the mean (SEM) ◆ The teacher defines the reliability and validity of test methods and explains them with metaphors	30 min.	◆ PPT (Unit 4) ◆ Student workbook ◆ Teacher's guide
(6) Skills in drawing graphs using MS Excel ◆ The teacher demonstrates when and how to use MS Excel to plot graphs (bar charts in series and scatter plots) (or by videos*) ◆ The teacher demonstrates the functions of MS Excel (AVERAGE, COUNT, STDEV.S, T.TEST, CORREL, SQRT, error bars). With a set of data given, students follow step by step to practise drawing graphs and using these functions (or by videos*) ◆ The teacher explains how to study the relationship between two parameters in terms of a correlation coefficient ◆ Using their data collected in field sites, students are guided to draw appropriate graphs with respect to their topics of investigation ** Video watching can be as a home assignment (total length: about 40 minutes).*	75 min.	◆ PPT (Unit 4) ◆ Student workbook ◆ Teacher's guide ◆ Google excel form ◆ Excel form (with a set of data given) ◆ Videos about Excel functions and graph plotting
(7) Analysis of data and students' presentations ◆ 45 minutes are allowed for students to analyse their data, do web searches and prepare for presentations* ◆ Each student group conducts a 5 or 10-minute presentation of the findings ◆ Students describe and analyse data using standard deviation (SD), standard error of the mean (SEM) and error bars ◆ Students take part in Q&A sessions after each presentation ◆ The teacher comments on the presentations, ◆ rectifies incorrect statements and shows appreciation ◆ Students make an overall comment on the water quality of the 2 field sites (or make a comparison between the 2 field sites) ** Analysis of data, web search and preparation of presentation can be done as a home assignment.*	1 hr. 15 mins (excl. * / 2 hr. (maximum)	◆ Student workbook ◆ Students' PPT for presentations

Description	Duration (hr/min)	Resources
(8) Debriefing ◆ The teacher reviews the knowledge covered in all sessions ◆ Students reflect and conclude their work	10 min.	◆ Student workbook
Total	**5 hr. 35 min. (excl. * in (7) / 6 hr 20 min. (maximum)**	

*Remark: (#) Around **0.5** non-contact hours are expected (for data entry and data checking)*

3.4.4 Assessment

- Success in preparing temporary slides of phytoplankton would be noticed
- Success in Gram staining and counting of bacteria would be noticed
- Success in observing bacteria under different magnifications in a compound microscope would be noticed
- Students' participation in chemical tests would be reviewed
- Success in drawing graphs in MS Excel would be noticed
- Students' understanding of standard deviation (SD) and correlation coefficient would be assessed through a student worksheet with short questions
- Students' ability to analyse and present data would be assessed through the quality and clarity of the 5- or 10-minute presentations

Manuals	Descriptions
Manual A	Use of a Van Dorn water sampler, a Horiba water quality checker, a plankton net, and a Secchi disc
Manual B	Basic operations of a compound microscope and an auto-pipette
Manual C	Information about phytoplankton/microalgae (with identification key of phytoplankton found in Hong Kong waters)
Manual D	Manuals of cultivation of bacteria, Gram staining, microscopic observation, nitrate and phosphate concentration test, E. coli test (by Petrifilm E. coli / coliform count plate)

Video number	MS Excel function / application
Excel-01	AVERAGE
Excel-02	COUNT
Excel-03	STDEV.S
Excel-04	SQRT and SEM
Excel-05	T.TEST and p value
Excel-06	CORREL
Excel-07	Scatter plot
Excel-08	Bar chart (Mean with SD)
Excel-09	Bar chart (Mean with SEM)
Excel-10	Series bar chart

4. Proposed rundown for the field study

4.1 Proposed rundown for 1 full day (simplified, more compact)

Time	Tasks
8:50-9:00	Check up for field trip equipment
9:00-9:40	Welcoming and briefing
9:40-10:15	HKMU/ School to the field site(s)
10:15-11:00	Teaching: On-site briefing Students are acknowledged of the position of first aid box
11:00-12:45	Student session: Students use equipment under supervision
45 mins break (light lunch self-provided)	
13:30-14:00	Traveling from site to HKMU/ School
14:00-14:30	Cleaning of equipment Teaching: Cultivation of bacteria and incubation of *E. coli*
14:30-15:00	Teaching: Preparation of temporary slides, use of a compound microscope and auto-pipette
15:00-15:30	Student session: Microscopic examination of phytoplankton
10 min break	
15:40-16:40	Teaching: To guide students through the discussions with groupmates Student session: Graph plotting using MS Excel and preparation of PowerPoint slides for presentation
16:40-17:55	Group Presentations Peers' and teachers' feedback

4.2 Proposed rundown for 2 days (comprehensive, in depth)

Dated you look awesome	Tasks
Day 1	
09:35-09:45	Check up for field study equipment
09:45-10:25	Welcoming and briefing
10:25-11:00	HKMU/ School to the field site(s)
11:00-11:45	Teaching: On-site briefing Students are acknowledged of the position of the first aid box
11:45-12:45	Student session: Students use equipment under supervision
45 mins break (light lunch self-provided)	
13:30-13:45	Travel to field site 2
13:45-14:25	Student session: Students use equipment under supervision
14:25-14:30	Clean-up of equipment • Dismiss at site • Cultivation of bacteria and incubation of *E. coli* is performed by a lab technician • Students' take-home assignments:

Dated you look awesome	Tasks
	1) Data input of Day 1 data to online Google excel form 2) Video watching (about MS Excel functions and graph plotting)
Day 2	
09:30-09:45	Briefing
09:45-10:35	Teaching: Cultivation of bacteria and incubation of *E. coli* Teaching: Preparation of temporary slides, use of a compound microscope and auto-pipette Student session: Microscopic examination of phytoplankton
10:35-11:15	1. Gram staining of bacteria and observation of bacteria using compound microscopes 2. Colony count of the petrifilm *E. Coli* / coliform counting plates
15 min. break	
11:30-12:25	1. Test for nitrate/ammonia 2. Test for phosphate 4. Data input to online Google Sheet form
65 min. lunch break	
13:30-14:00	1. Understanding measurement error 2. Understanding the reliability and validity of test methods
14:00-15:15	1. Knowing the functions of MS Excel 2. Drawing graphs using MS Excel
15 min. break	
15:15-16:00	1. Analysis of data according to investigative topics 2. Web search (if needed) 3. Preparation of PowerPoint for a 10-minute presentation
16:00-17:15	1. Group Presentation (5 groups) 2. Q&A sessions and comments for each presentation
17:15-17:25	Debriefing

5. References

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