Algae in our backyard : An ArtScience Exploration

The algae in your backyard: Day 1

2 hours, 20 minutes for 50 students

**Overview**: This course is an exploration of marine algae (phytoplankton) through several scientific and artistic processes. The content will cover several important topics in ocean biology and ocean change, and several key methodologies in both art and science. Students will be exposed to different scientific data, from microscopy (using local water samples for observations) to satellite (using downloadable maps of the South China Sea), and learn how these data help us understand ocean processes and “local” issues that affect the South China Sea. In addition, students will use photography, scientific illustration and data visualization to learn, reflect and communicate the information they have gathered from the microscopes and satellite maps. This will result in a final exhibit combining scientific and artistic processes and findings.

**Structure of the day**: Day 1 will focus on several themes: the role of algae in the health of our oceans and planet, scientific approaches to observing algae in local bodies of water, and the role of art in the process of understanding water and the ocean. We will explore examples of data collected using microscopes and satellite, and examples of how art informs science and our understanding of the water around us. By the end of today, students will have the opportunity to photograph/image some of the microscope and satellite-based observations, adapt the images using photo editing software, and print these images out.

**Learning objectives:** *Write the learning objectives on the board*

* + Learn about microscopy and using a microscope to observe phytoplankton
  + Comprehend the link between phytoplankton and human quality of life
  + Explain the effect of human actions on marine life in the South China Sea
  + Discover how artistic & scientific processes are similar and ways they overlap
  + Learn about artists who use water and/or scientific processes in their work
  + Analyze and compare two types of observations of phytoplankton in the South China Sea
  + Learn how to photograph through a microscope and manipulate the photo with an online digital photo editing program

**Materials to be divided into two between two classrooms, 25 students per classroom:**30 Digital microscopes (15 per classroom)

A few standard light microscopes available at the school already  
50 Field notebooks for students to take notes (25 per classroom)

50 copies of 3 handouts: course outline, data analysis activity, and one about pixlr

Premade slides (2 sets= 20 decent slides per room)  
Nalgene sample bottles  
Fresh slides  
Macbooks (not sure how many yet but hopefully 15)  
Pencils

**Preparation for this day:**

* On 12 desktop computers, store ~191 monthly satellite .nc files into the folder *algae\_module\_day1*
  + All are on the dropbox folder now
* Install Anaconda and ipython onto 12 desktop computers in classroom.
  + Download Anaconda distribution onto computer (Python 3.6???) here https://www.anaconda.com/download/#macos
  + Open terminal on computer
  + Type *conda update conda*
  + Type *conda update ipython*
  + General instructions for this on: <https://ipython.org/install.html>
* Prior to day one, instructors will fill 5 nalgene sample bottles with water from 1-5 different beaches in Hong Kong, and 5 bottles with faucet water. Label each sample with location and date.
  + Instructors will divide the faucet samples onto 30 slides. Label slides (faucet).
  + Also divide 5 beach samples onto 30 slides. Label slides with sample info (location and date of sample).
  + \*\*Honestly, if you see people swimming, collect the beach water. I don’t want you to touch any water that could potentially be really dirty! If it doesn’t seem clean, just go with the faucet water and pre-made slides for the activity.
* Set up 15 microscope stations per classroom
  + Right before the class starts on day 1, each instructor in each classroom will distribute 15 microscopes around each room. Each microscope station will be accompanied by three slides: one beach sample, and one faucet sample, and 1 pre-made slide of one algae purchased online. Out of the pre-made slides, only choose from the 10 best slides.
  + Connect microscope to computers. Note that # computers will affect # microscopes you can use.
  + Instructors should write on the board what each slide label means so the students know what specimen they are looking at, where it was collected, and when it was collected.
* On ## (15?) desktop computers in each classroom, create a folder called *algae\_module\_day1* on the desktop. The folder will also contain a script to plot satellite data maps of phytoplankton distributions in the South China Sea (called *Module\_Satellite\_Script.ipynb*). This will be used during the satellite data analysis part of the class.
  + Do run through of the satellite activity on each computer. Plot one map from one month/year

**Run-through:**

* **[5 min]** Go over learning objectives for the day
  + Hand out field notebooks for students to take notes, write down thoughts and make sketches during the module. They can personalize them.
  + Point out microscopes
  + Hand out art supplies
  + Art and citizen science powerpoint? – this will be up to you whether to present this here or later
* [**20 min= 10 + 10**] Introduction to phytoplankton using microscopy.
  + Ideal outcomes of this activity are
    - Demonstrate to students how to use a microscope to observe phytoplankton
    - Get the students to practice science and art techniques (they overlap here because they involve observation and communication to others)
    - Illustrate the diversity of phytoplankton
  + Assign groups of 1-2 students per microscope station (15 total).
  + [**10 min**] In their field notebooks students should do the following. This prompt will be on slide 1 of Phyto\_Micro\_Space.ppt file
    - Note the information of both slides
    - Note the microscope’s magnification they choose for each slide
    - Write down observations of what they see (size, shape, color, etc.) on each slide
    - Draw one object that they see in the field of view of one slide
    - Compare drawings with a partner
    - Students can walk and around swap pre-made slides to image different ones, so long as they continue to record what they see
  + Instructors can walk around classroom during this 10 min activity to visit groups and answer questions.
  + [**10 min**] Group discussion involving the whole class.
    - Instructors will select 3 different groups to talk about their observations (water samples, magnification, observations) to the entire class
    - Instructors ask all of the students to explain why there were differences between the groups. The answers include species type, specimen location, and natural variation in the way human make observations and see detail
    - Instructors will write the student responses on the board as well.
  + Possible questions that will come up during discussion
    - Refer to algae slides info for specific information about species on pre-made microscope slides
    - What are the specimens on the pre-made slides?: refer to notes on google drive
    - What phytoplankton can you find along the beach in Hong Kong?: You maybe just want to visit the following links that talk about presence of Sargassum/seagrass, dinoflagellates
    - https://www.afcd.gov.hk/english/country/cou\_vis/cou\_vis\_mar/cou\_vis\_mar\_sargassum.html
    - https://www.scmp.com/lifestyle/technology/article/1661757/hong-kongs-algal-blooms-red-alerts-nature
* [**20 min**] Powerpoint lecture of what phytoplankton are and ways to observe them with microscope and satellite. Talking points in powerpoint slides. Slides 2-24 of Phyto\_Micro\_Space.ppt file
  + Basic information on what phytoplankton are
  + Ideal outcomes of this activity are
    - Teach basic information on what phytoplankton are
    - Show historical illustrations of phytoplankton
    - Global relevance of phytoplankton in the food web
    - Introduce satellite imagery, and what you can learn from it
  + We have technically worked with one type of scientific data that is very important for observing algae: microscopy. Now students will start to explore another type of data from satellite images of the ocean surface.
  + The slides will provide basic information on how satellites work, how you can infer phytoplankton abundance from satellite, and what cool concepts satellite data has allowed us to explore related to phytoplankton populations in the ocean.
* [**30 min**] Satellite data map analysis of phytoplankton in South China Sea.
  + Ideal outcomes of this activity are:
    - Giving the students some experience with large data sets, which they can compare with the microscopy
    - Illustrate ocean processes with the data sets
    - Introduce the concept of data representation (colors on maps are not reality but representations of it) - a theme that overlaps with illustration and artistic representation
  + [**5 min**] Introduce and explain activity using powerpoint (Slides 25-34 of Phyto\_Micro\_Space.ppt file)
    - Explain handout too.
    - Explain where the South China Sea is on the map.
    - Explain how students will manipulate a Python script on the computer to make satellite maps from different month/years (between July 2002- May 2018).
    - Explain what students should record in worksheet/notebook.
  + [**15 min**] In the same groups as the microscope groups, students will share a total of ## (15?) computers to plot maps of algae over the South China Sea.
    - During the activity, instructors will move around groups to answer questions from the students, check their progress.
  + [**10 min**] Then, the class will gather all their attention again to the instructors, and ask 3 groups of students (preferably different from those that presented during the microscope activity) to share some of their observations.
    - To focus, instructors should ask: What patterns do they see in the different maps that they have explored? Patterns in space and time
    - Instructors also ask: what have the students learned from this type of data that is different from microscopic observations?
    - These questions will be on handout too.
  + Possible questions/comments that students may bring up
    - There are more algae close to shore (i.e., warmer/redder colors close to shore, which indicates greater chlorophyll concentrations). Why?: Because there are more nutrients being washed off the land, from urban waste and agriculture, into the sea
    - There are fewer algae further from shore (i.e., bluer colors, which indicates lower chlorophyll concentrations). Why?: Because there are fewer nutrients out there, less influence from human activities
    - Why do clusters of algae appear cloudy or wispy as they spread out away from the coast?: patterns in ocean circulation affect the delivery of nutrients to algae communities at the surface. These patterns are driven by wind, ocean currents, and mixing of deep and shallow water.
    - The # of algae (i.e., ocean color) away from shore changes a lot. There are more algae in January 2018 than in April 2018. Why?: Changes in winds. Winter monsoons can deliver more nutrients to the surface ocean in January, causing more algae to be able to grow.
    - The # of algae (i.e., ocean color) along the coast changes less. There are about as many algae in January 2018 on the coast than there are in April 2018 on the coast. Why?: There is always high runoff of waste/nutrients from land to sea throughout the year.
    - Why does the distribution of algae (map colors) look similar between the same month of different years. For example, why does the January 2018 map look like the January 2017 map?: Because algae populations have a seasonal pattern. Just like trees, their communities grow and die at specific times of year in response to seasonal changes in the environment, like the monsoons.
* [**12 min**] Short group activity on algae and water quality, to directly follow up on the data analysis activity. Slides 35-38 of Phyto\_Micro\_Space.ppt file
  + Ideal outcomes of this activity are:
    - Teach students about phytoplankton blooms
    - Show students how the different scientific tools that they learned could be used to address local environmental issues
    - Teach some aspects of the scientific method.
  + [**2 min**] From the satellite data activity, students should have noticed that there are more phytoplankton on the coast.
    - Sometimes, near Hong Kong, there is so much urban/agricultural runoff into the coastal ocean from land, phytoplankton blooms happen
    - Refer to slides explaining phytoplankton blooms
  + **[5 min**] Instructors ask students to work in groups of 4-5, and brainstorm questions related to local algae blooms. These questions can address things that make them curious, and/or issues that they think would be important to find out for protecting the environment.
  + [**3 min**] Instructors call on all groups to share one question.
    - Write questions on the board.
    - Together as a class, discuss how students could use microscopes or satellite data to address each question.
    - They should record their ideas in their journals
    - At end, instructors should emphasize that the students are scientists now and can use the scientific method (inquiry followed by planning, hypothesis formation and testing through observation) to solve environmental problems. Now, can the arts can also provide an approach to addressing water issues like pollution?
  + Possible questions that students may bring up
    - Why are blooms composed mostly of one type or a few types of algae?: This type (these types) of algae outcompetes all others in consuming the nutrients from urban/agricultural runoff
    - How are these blooms dangerous?: They are not necessarily dangerous to humans. It depends on the species of phytoplankton in the bloom. Some species are toxic – they can cause you to get sick from eating them, eating the fish that eat them, or swimming in them.
    - Do these blooms happen in Hong Kong?: Yes. But we are not sure about the environmental effects of these blooms yet.

* **[43 min]** Time for students to return to phytoplankton images from microscope, and/or satellite, and select images individually
  + Photograph a few of the microscope observations
  + To begin choose at least one of those images to alter
  + Transfer it onto your computer
  + Image manipulation
    - Using a free online photo imaging/editing pixlr.com have students manipulate their photograph to highlight and showcase what they have found in the microscopes - as well as use self-expression to demonstrate creativity and understanding.
    - Employ at least three tools from pixlr.com to manipulate photo.
    - (see attached worksheet https://drive.google.com/open?id=1xOB1uvI\_b1ZXYVLWG5bvUIhUcMsXCjx- )
  + \*\*Challenge - combine both an image from the microscope and the data maps
  + Print out images
  + They day will end with some reflection in student journal about what they learned in the day, any questions that they have going forward, and why they selected specific images for print

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The algae in your backyard: Day 2

2.5 hours for 50 students

**Structure of the day:** Day two will focus on project development, feedback and reflection. The students will come into class with their printed images, and with an idea of how they will illustrate and render the information on these images, and any other microscopic/satellite-based observations into visual art. After drawing, the students will engage in a critique session that exemplifies constructive criticism and a safe space for giving feedback in a classroom. By the end of class, the students will prepare an artist/scientist statement reflecting on their scientific observations and artistic processes.

**Materials:**

Watercolor paper

Watercolor pencils

Artist/Scientist Statement Handout

Pencils

Learning Objectives:

* + Learn about and create a scientific illustration based on their photograph/observations.
  + Apply art/design related activities to achieve creativity, collaboration and communication in the classroom

Reflection on the prior day - they can show their prints of the digital manipulations and/or discuss any interesting facts and ideas they learned.

* **[10 min]**

Presentation about scientific illustration and data visualization

* + More examples of blend of art and science related to water
* **[10 min]** Students will work in small groups to discuss their plan for illustration and/or how to visually represent their data with the photo from the day before
  + Group discussions for practicing communication, sharing feedback and reflection
  + Share & discuss ways to exhibit work
    - Instructors can note that the final ceremony at the end of the STEAM school can be used as a venue to showcase their works: during final exhibit
    - Can the illustrations be arranged as visual data to showcase learning?
    - What is the intention of the exhibit? What do you want to show?
* **[10 min]** Illustration demo - demo of specific illustration techniques and how to use the watercolor pencils - (tips and tricks for drawings etc.)
  + Instructor will give a demo of some tips for drawing such as
* [**35min**] Students work on their own illustrations/data visualization
* [**10min**] Critique session
  + more extended info on leading a critique session in attached handout
* [**10min**] Finish working on illustrations, taking into account the feedback from the critique.
* [**5min**] Go over the Artist/Scientist statement handout
* **[15 min]** Personal time to reflect and write statement that will be paired with illustration/data visualization
* [**10min**] Final sharing/ gallery walk/exhibit
  + post-it notes to comment on artwork