Impact Objectives

- Highlight for students the relationship between human activity, water quality and environmental indicator organisms
- Develop simulation software to allow students to set up their own river basin environments and use diatoms to learn how they impact water quality

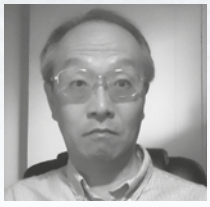
A water education programme changing stewardship

***Professor Shigeki Mayama** talks about his work with **Professor Matt Julius**, **Dr Karthick Balasubramanian**, **Professor Kazuhiro Katoh** and **Assistant Professor Hiroshi Omori** on an international collaborative project that is fostering students contributing to global water stewardship through education*

Professor Shigeki Mayama

Professor Matt Julius

Dr Karthick Balasubramanian



Professor Kazuhiro Katoh

Assistant Professor Hiroshi Omori

How did you come to be involved in the SimRiver research initiative?

I have studied diatom taxonomy and ecology for more than 40 years and also developed the water quality evaluation method that has since been adopted by the Tokyo Metropolitan government. In the early days of my research, rivers in Japan were heavily polluted everywhere but today, the terrible conditions have thankfully been overcome. I have experienced this history of change in the river environment first-hand. The university I work for is the largest teacher training university in Japan, so I have always tried to convey science based on educational theory in university students' education and in-service training. To achieve the skills required for modern life, we need to ensure competency, not just knowledge. Through my current project, I would like to foster children's competencies and contribute to global water stewardship through education. I am based at the Advanced Support Center for Science Teachers at Tokyo Gakugei University Koganei in Japan where we develop science teaching materials and methods, and provide in-service training for science teachers who can effectively foster children's science skills in primary and secondary education. As science progresses, we want to introduce new fields of learning at the same time as keeping the basics in mind.

You have been working closely with collaborators on your latest project. Can you talk about their role in the research?

Katoh is responsible for developing SimRiver's water quality–diatom model and the statistical analysis of the educational activities. Omori is looking after the substantive programming of SimRiver, which is important for this project's ICT-based materials. Julius and Karthick are providing past and present diatom specimens, and river photographs and videos in the US and India, respectively, as well as mentoring teachers and setting up classes in schools in both countries. Karthick is also assisting with local language translation with his team. They have been an integral part of our project as we deal with different times and nations in our educational programme.

Ultimately, you want to expand the scope of your project to include more countries. How do you hope to achieve this?

We are seeking the help of researchers from different countries who can provide past and present diatom specimens. We are also looking for schools from a variety of countries to support our project and conduct classes. It is important to add diatom specimens from diverse countries to our teaching materials that tell the story of past and present river environments – and when schools from diverse regions participate and form a network, we can better foster global competence. We are also keen to find sponsors who understand the project and can provide funds that our collaborators can then use in their respective countries. ▶

Using the past to shape the future

A global team of experts is helping to show students the relationship between human activity, water quality and environmental indicator organisms through the SimRiver project. The findings should help students develop their scientific understanding and shape their own world in the future

Human activity has long been known to cause significant harm to the world's environment, from global warming and the resultant climate change, to depositing plastic into oceans and destroying marine life. However, there is something novel about the difference between river pollution in developing and developed countries, which relates to time.

For instance, developed countries, such as Japan and the US have a history of polluting their rivers and have done for centuries. Efforts to correct this have only occurred in the last half century. On the other hand developing countries historically had relatively clean rivers, with increased pollution occurring in recent years as economic development expands. We can therefore surmise that in the past, rivers in developed countries were just as polluted as rivers in today's developing countries. In other words, the history of river water quality is the opposite in developed and developing countries.

This knowledge provides an opportunity to use the past to instruct the future. Textbooks and literature over the years offer descriptions of past water quality everywhere; unfortunately, samples of this past water are nowhere to be found. There are old specimens of aquatic organisms in laboratories and museums, but not the water they lived in. To help address this gap in knowledge, a team of scientists has uncovered a means of ascertaining past water quality and how it relates to today's environmental concerns. The hope is that by helping children to understand how human activity affects river environments scientifically, they will be well placed to develop solutions to these problems in the future.

DIATOMS AS BIOINDICATORS

The team of researchers is led by Dr Shigeki Mayama, who is based at the Advanced Support Center for Science Teachers at Tokyo Gakugei University Koganei in Japan. They are developing an educational programme that fosters children's scientific competencies using microorganisms known as diatoms. 'Diatoms grow in any water body, such as rivers, lakes and oceans, are responsible for 20-25 per cent of the global photosynthesis, and are used worldwide as bioindicators for environmental assessment,' explains Mayama. 'Diatoms are often overlooked as something to include in school education, but as organisms, they are deeply involved in our lives, so we set about using them in our programme.'

Using bioindicators, the team is able to estimate the quality of the water that the organisms lived in. However, while this is useful, it does not explain what caused the water to be of that quality. Mayama and his colleagues decided to develop simulation software called SimRiver. SimRiver simulations allow students to set up their own river basin environments and use diatoms to learn how they affect water quality. 'Because the simulation results are displayed in a short period of time, students can repeat the simulation multiple times during class time, which is useful for forming a generalised concept of the impact of human activities on water quality,' he outlines.

SIMRIVER AND THE REAL WORLD

SimRiver is available in 22 languages which attests to the team's desire to involve as many children in as many countries around the world as possible. The software's interface is graphical and the operation of it is similar to that of video games, which is a conscious effort on the part of the developers to make it as appealing as possible to students.

Having said that, working on a virtual environment can be challenging at times, especially concerning a lack of a sense of reality when results are gathered. 'We supplement SimRiver with actual specimens we collect from the river,' comments Mayama. 'Diatoms are proxies for the aquatic environment and the fact that they have appeared in the past or are appearing now is irrefutable evidence that an aquatic environment existed in which they could live. By combining virtual simulations with real-life specimens, we can provide students with effective learning.'

USEFUL TOOLS

SimRiver works by enabling students to observe collections of past and present

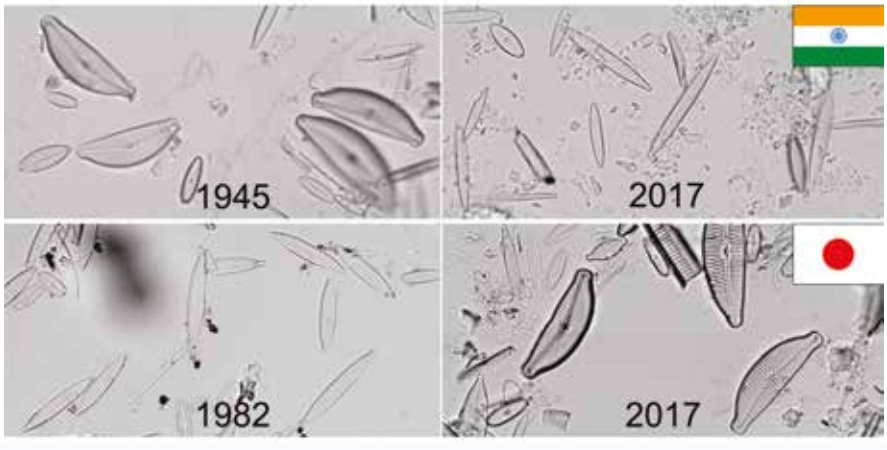
diatom specimens from the same location in the same river from their home country (without revealing which specimens are from collections made in the past or present). Then, using the software, students are able to set up various river surroundings to simulate and create virtual specimens that resemble the community composition of each real specimen.

> *'By combining virtual simulations with real-life specimens, we can provide students with effective learning'*

The iterative process of hypothesis setting and testing provides training in scientific inquiry, and experiencing this process fosters scientific competency in the children. 'After students understand the environment in which the diatom assemblages of each specimen occur, I show them photos and videos of rivers from each era,' explains Mayama. 'Next, students observe a specimen from a foreign country, but because they understand the various relationships between diatom assemblages and the environment through simulations, they can infer the past and present river water quality of the country on a scientific basis.' By helping the children scientifically understand the causes of pollution, consider the social factors involved and be aware of the history of solutions, it is hoped that they will be able to think about what they can do to solve the problem. Mayama makes the point that children in developed countries tend to be prejudiced against dirty rivers and the people who live in such areas, but he believes that by helping them to understand that their own countries were once in the same situation as developing countries, they will think about solutions on an equal footing with children in developing countries and without prejudice.

A TRULY GLOBAL UNDERTAKING

The project is currently being conducted in Japan, India and the US, but the team hopes to make the project more global in scope and seek supporters for the projects in regions around the world. With SimRiver being available in 22 languages, other related materials currently translated into 25 languages and all being free of charge, Mayama and his team are keen to see that secondary schools around the world incorporate this programme into science and environmental curricula. ●



Comparison of diatom specimens collected from past and present rivers in India and Japan

Project Insights

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COLLABORATORS

Researchers and teachers from 23 countries - www.u-gakugei.ac.jp/~diatom/index.html

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BIO

Professor Shigeki Mayama has been studying the biology of diatoms from a broad perspective for over 40 years. He is also a leading researcher on river environmental education by diatoms.

Professor Matt Julius leads the anaerobic digestion and biomass production team at St. Cloud State University.

Dr Karthick Balasubramanian leads the diatom diversity and distribution lab at Biodiversity and Palaeobiology Group of Agharkar Research Institute, Pune.

Professor Kazuhiro Katoh is based at the Open University of Japan and teaches ecology through distance education.

Assistant Professor Hiroshi Omori is based at the Laboratory of Biometrics and Bioinformatics, Graduate school of Agricultural and Life Sciences, The University of Tokyo.

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