

TEACHING PORTFOLIO

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“A Pioneering Role in Interdisciplinary Experiential Education”

CONTENTS

1. Summary
2. My teaching philosophy
3. My journey of teaching interdisciplinary science, technology, and business
4. Integrated overseas and mainland experiential education: my novel experience
5. Nature's toolbox” for overseas experiential education: my novel experience
6. Hands-on training and exposure to industry is an accelerator for science innovation and entrepreneurship
7. Innovative curriculum design and execution: an interdisciplinary teamwork
8. The Way Forward

1. SUMMARY

Five key points to summarise my innovative teaching and learning experience since I have joined HKU in 2008:

- My outstanding teaching and learning career at HKU have been driven by my passion for **experiential education** using overseas (and mainland) field trips and **interdisciplinary collaboration**, which is repeatedly praised by my students, mentors, colleagues, school heads and deans. This teaching philosophy is firmly reflected in all courses that I have designed and teaching at HKU for environmental science and ecology curriculum,
- **Student evaluation** of my teaching effectiveness, i.e. SETL scores, over the past 12 years in >25 courses are consistently higher than departmental average – my student's feedback constantly contains praises such as: “passionate”, “interesting lecture”, “inspiring”, “clear explanation”, and “interactive teaching”.
- Review of my teaching through HKU's performance review and development (PRD) exercise by two senior colleagues and school head over the past 10 years have been consistently rated as “**A to A+ or consistently exceeds expectations**”
- Developed a **research-led** advanced overseas experiential learning course with field-based hands on training (BIOL4505) and a **common core course** (CCS 9070) with innovation using an interdisciplinary (joint teaching by science, engineering and medical faculties and or with industry partners and government officers) collaboration – pleased with students' feedback and award-winning innovative projects
- As the **assistant dean for experiential learning** in the faculty of science, the student advisor for Ecology and Biodiversity major and a founding member of the Environmental Science major management board, I have been implementing various dynamic measures to ensure that all our UG students will have completed at least one overseas and mainland experience by the year 2022.

2. MY TEACHING PHILOSOPHY

I am a strong believer in 1) interactive teaching with great passion, enthusiasm and dedication, 2) research-led, hands-on and field-based education, and 3) exposure of students to interdisciplinary platform for innovation and to explore entrepreneurship in science. Implementing my teaching philosophy and my path of pioneering experiential education at HKU was not without mistakes and difficulties along the way. However, it is my strong belief that teaching is a learning process that I undertake with my students and colleagues, and I was very fortunate to have many fine students and senior colleagues with me at HKU. My task of teaching research-led and field based environmental science courses, ecology internship training and overseas experiential education at HKU is a very remarkable experience, and the best lesson that **I have learned along the way of teaching these courses is to 1) deliver interactive lectures, 2) have student-led group projects and presentations as part of course objective ad assessment, and 3) engage students using problem-based learning and field trips.**

Almost all my courses are **research led**, i.e. encouraging students to read original research papers or participate and carry out some sort of actual research during field trips. Such research driven education is important for fostering an understanding of environmental sustainability in an active, dynamic process. One of the best ways to implement this research based learning is by creating opportunities for students to participate in field observation, collection of data, understand **real-world issues from nature**, and scientifically analyzing those data (and issues) in small groups for subsequent presentation of new ideas with solution as part of course assessment. Notably, I have been using case studies from **local environmental issues** that are familiar to them to guide students through the process of developing novel hypotheses and understanding what scientific data and critical thinking skills are needed to accurately test these hypotheses. I have successfully adapted this philosophy in majority of my courses, including the ENVS 1301 – a large size (80 to 100 students) introductory year one course.

My advanced Year 4 courses, final year projects and internship training are primarily focused on training towards the development of **novel entrepreneurship project plans** to solve environmental management issues or to develop sustainable aquaculture tools. My strong advice and belief is that all our science undergraduate students, irrespective of their major or future carrier, should have research-led (e.g. Final year project) entrepreneurship project development skills (e.g. my course like BIOL4505) to excel in modern world. I have also advised and worked with students for over 25 undergraduate research projects and encouraged all students I have encountered to seek out opportunities to get hands-on experience in government agencies or NGO's related to environmental management or in any industry related to their major study. Such field and industry projects and any related working experiences would create an opportunity for students to apply what they have learned in the classroom to real life experiences. Whenever possible I also include such field observation, learning and real-world experience as part of my teaching, course assessment and curriculum development.

Today's science teachers need to acquire new knowledge from cutting-edge research findings and then communicate well with their students using variety of **electronic (e.g. WhatsApp, Facebook research pages) and social communication (e.g. being part of student society functions and gatherings) tools**. Teaching is in itself an educational opportunity for the teacher,

since we can also learn from our students. It has thus been my core philosophy that it is a privilege to teach, not simply a duty to fulfil. Learning and teaching is the primary mission for the sustainable development of every generation. What is the purpose of our learning and development today, if we cannot pass down such knowledge and experience to our future generations? Like every pioneering path our predecessors explored, the road of innovation and bringing interdisciplinarity in science education will never be a smooth ride, but it is the only means to break through the current limits and boundaries of our largely faculty based curriculum development. I have recently experienced the importance of **interdisciplinary teaching and curriculum development** (e.g. common core course - CCST 9070 Inspiration from Nature).

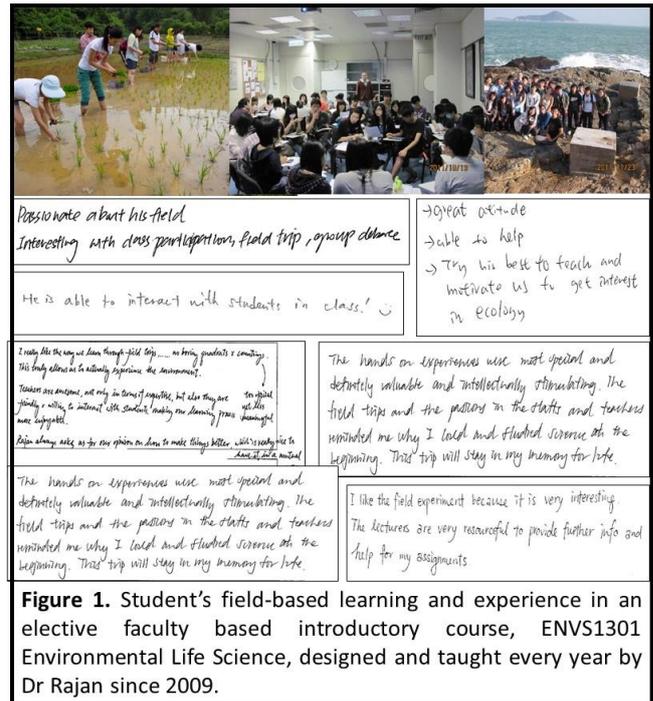
I have been fortunate to be an academic and course selection advisor for over thousands of students since 2008 and got a golden opportunity to guide students from 15 majors at faculty of science as assistant dean for experiential learning. One of the most important aspects of my career as student advisor, mentor and teacher is the development of innovative ways and applications of modern communication tools to strengthen the bonding between students and teachers. I have been fully committed to my role as an Academic Adviser for our students and enjoy meeting with students to address all issues related to their academic careers. During my course and advising, I make sure to establish an atmosphere of mutual respect and understanding where each student feels like they have an opportunity to have their voice heard. I encourage students to interact with me and with each other in a small group, both in class, in my office and out of the classroom, especially during field trips.

3. MY JOURNEY OF TEACHING INTERDISCIPLINARY SCIENCE, TECHNOLOGY, AND BUSINESS

My path of developing several new interdisciplinary teaching materials for both introductory and advanced experiential learning courses was not simple and direct, but was a process of repeated self-reflection and learning from mistakes, as reflected in the evolution of my teaching evaluation results (e.g. my teaching effectiveness scores over the past 12 years are much higher than departmental average). Teaching skills are built by a process of continuous improvement with non-stop learning of new knowledge. For me, it is also a process of making mistakes, facing mistakes, correcting mistakes, and getting invaluable benefits from these experiences. I deeply appreciate every HKU student who has taken my classes, because they are truly my “teachers” who have guided me to design the best course materials and finding the most effective way of delivering them. My satisfying teaching career would not be possible without their feedback and assistance in pointing out their questions and difficulties. I like learning new things, and this has been clearly shown in my interdisciplinary education and research direction.

Bigger Year One Course - Environmental Life Science: In 2008, I created the “Environmental Life Science” module, spearheaded by the newly developed Environmental Science major in the faculty of science - “ENVS 1002”, which was the predecessor of ENVS1301 in the new 4-year curriculum. ENVS1002 and 1301 are the Year-1 flagship courses not only in the Faculty of Science but also listed as one of the elective courses at HKU level (under the theme “Life and Environment”) and have had over 80-100 students from various faculties (mainly science and engineering), in the course each year (Figure 1). There is no textbook available in the environmental science education community to guide instructors how to teach this new concept of learning of environmental life science and sustainability using experiential learning and field-based group

projects, which has developed only within this past few years. I benchmarked, synchronized and produced course materials from many of my ecology research and course-taking experiences, and designed the pedagogy for setting learning outcomes, effective delivery, appropriate exercises, and assessment methods fitted to our science and non-science students. Alongside my pioneering work of creating the course materials and activities, I always encourage students to be innovative and pursue learning for fun in this new and still-evolving subject. For example, in teaching the three essential considerations of “ecosystem function”, “biodiversity”, and “human-ecosystem interactions” that support sustainable development, I expose students to several day long exposure to various field sites that are facing environmental sustainability issues (see Figure 1). I often use local environmental issues and their management as a case study and involve students as stakeholders during the discussion (Figure 1).



Advanced Experiential Overseas Field Courses and Environmental Education for enhancing students critical thinking: My passion is building various platforms and collaborations for teaching environmental science through interdisciplinary collaborations. At HKU, I have got golden opportunity to experiment various experiential learning tools through launching several overseas field courses (SCNC2122, ENVS 3028 and BIOL4505). These experiential and exploratory field courses, involving teachers and students from multiple institutions, have proven to be highly successful (SET scores for Teaching and Course >85%) for stimulating student interest in environmental science. Currently, my science faculty is emphasising the importance of science entrepreneurship and innovation. To address this faculty's goal, I have designed a novel experiential learning course to enhance science graduate students interests in developing innovative ideas to solve science related industry problem through entrepreneurship skill set, e.g. BIOL4505 Aquaculture Technology and Business. I am pleased to know that students from these courses are setting up their own industry or joining the established industry to implement their innovative ideas developed during their undergraduate studies at HKU.

4. “NATURE’S TOOLBOX” FOR INTEGRATED OVERSEAS EXPERIENTIAL EDUCATION: MY NOVEL EXPERIENCE

Environmental science and science in general are a career that emphasizes observation and hypothesis testing in laboratory. I often encounter students confused as to why they need to study a lot of theories from textbooks using examples that they never saw, which do not seem to be immediately applicable to their local environments and future work. This indicates the disconnection between scientific concepts and real-world environmental problems. Basic environmental science knowledge is of course important to young scientists, and it is a “toolbox” for critical thinking and for designing innovative solutions. But, as an experimental scientist, I

have been always fascinated and inspired by observing nature while searching novel solutions for human-environmental nexus. For me, "Seeing is believing", and I constantly search for evolutionarily stabilised patterns in nature and then design experiments to resolve my doubts. This has naturally migrated to my teaching philosophy, and I have found it is much easier to help students grasp important concepts once they have seen them in nature and experiment them using field-based projects.

I found that the students' ability to interpret and apply the theories on their exams has greatly improved, and that the frequency of requests to review these concepts before the examination has also considerably reduced. For example, many students cannot picture how temperate coastal environments (Canada and USA) are sustainably managed to maintain high biodiversity when compared to tropical (Hong Kong and Malaysia) environments by just reading textbooks using traditional ecology courses. I quickly realized this issue and learning difficulties associated with typical textbook based education among our year one students. Therefore, thanks to the enormous support that I have received from school and faculty, I have designed and taught several introductory courses with experiential learning components such as field trips, experimental observation in nature and group projects. For example (Figure 2), the HKU and University of British Columbia (UBC) experiential learning course that I designed and taught for many years in collaboration with teachers from different expertise and background has proven to be highly successful (SET scores for Teaching and Course >85%) not only for stimulating student interest in environmental science but also in establishing a strong teaching collaboration between HKU and UBC. This course also



provided me an invaluable opportunity to enrich our experiential learning education and courses with the most innovative teaching methods and content. With wonderful students and supportive colleagues, my path of pioneering experiential learning education at HKU, while rough like in every new expedition, has not been undertaken alone. Some selected teaching developments during this pleasant journey are further highlighted in Figure 2.

5. ENGAGE STUDENTS FROM MULTIPLE INSTITUTIONS TO FOSTER TEACHING EXCELLENCE

I am a firm believer that new developments in teaching should be repeatedly tested and improved before it can be complete. With my pioneering experience in experiential field-based education using local and overseas environments, I had an opportunity to design an advanced experiential overseas course on coastal sustainability (BIOL3028), which added sustainability and management to environmental education, hosted and jointly participated by students from both HKU and Northeastern University. This joint advanced experiential learning course consisting of some of the most renowned environmental educators and learners (students) in the world, and I was very fortunate to have such an opportunity at HKU. In this course, students learned and explored with hands-on training on issues associated with coastal sustainability and ecology in 3 different parts of the world: Hong Kong, Malaysia and USA. Also, our HKU students were able to sit together with USA students to learn coastal issues (Figure 3). According to feedback, students have significantly improved their critical thinking skills in line with international students and found new way to link their knowledge to real-world problem and problem solving.



Figure 3. A joint experiment and collaboration in undergraduate education between the University of Hong Kong, University Sains Malaysia, and Northeastern University – a great success.

6. HANDS-ON TRAINING AND EXPOSURE TO INDUSTRY IS AN ACCELERATOR FOR SCIENCE INNOVATION AND ENTREPRENEURSHIP

The advanced experiential learning course that I have designed and taught since 2016 has helped to enhance students' knowledge in applied marine science, modern sustainable aquaculture technology and business (Figure 4). The experiential education has also enabled students to design, construct, operate and maintain oyster aquaculture facilities and small-scale “green and environmentally sustainable” business for shellfish production and restoration of wild benthic biodiversity in coastal habitats. This was an interdisciplinary endeavor encompassing hatchery technology, seafood quality, and economic dimensions of coastal aquaculture business. Students have been exposed to aquaculture facilities in Hong Kong and were taken to Qingdao (China) or

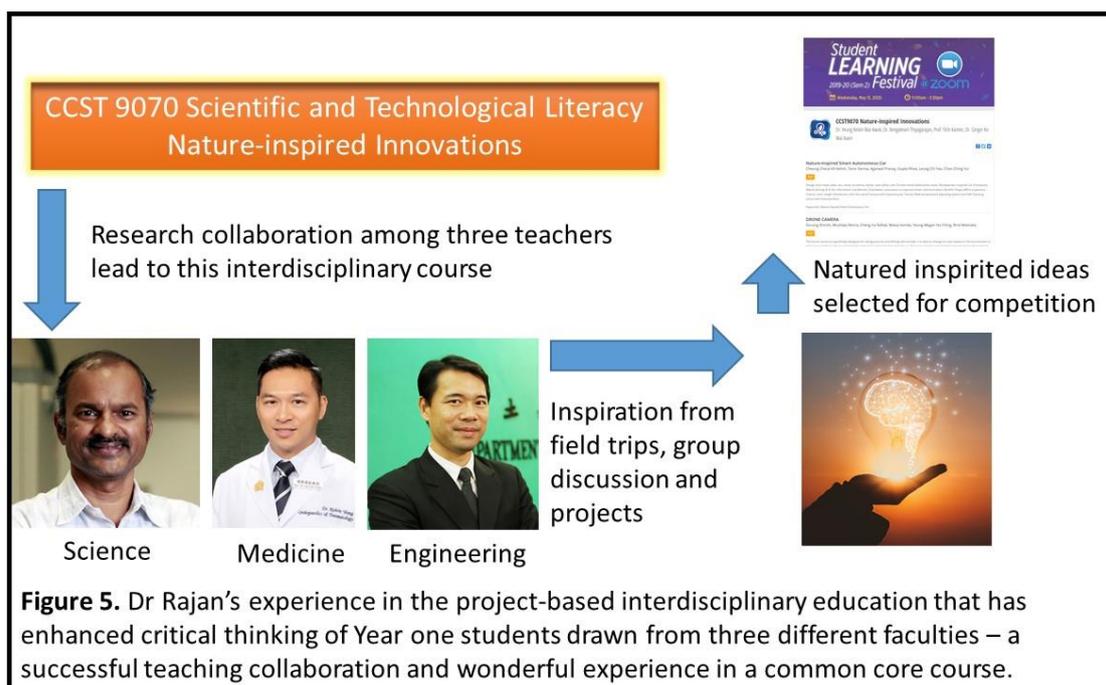
Penang (Malaysia) to learn practical skills of oyster aquaculture and to oyster sauce company (Lee Kum Kee) in Hong Kong besides local aquaculture village (Lau Fau Sahn). Students were exposed to a unique learning environment involving not only HKU teachers but also industrial experts, government aquaculture officers and local growers, who had diverse range of expertise, culture, and learning opportunities. This month-long course served as an accelerator or incubator or breeding ground for the innovation of novel science entrepreneurship ideas. A group of students, shown in Figure 4, from 2018 batch has created an award-winning idea from this course and have successfully launched their own company in Hong Kong (for details please see <https://www.biosch.hku.hk/a-newly-designed-shellfish-culture-raft-could-help-hong-kongs-beleaguered-oyster-industry-stay-afloat/>).



Figure 4. Dr. Rajan's course has successfully innovated a new experiential teaching toolbox to create science entrepreneurs. The course workflow is shown here - project-based learning in a small group leads to the development of business ideas or projects, selected ideas are developed into an award-winning project and finally it is converted into a company.

7. INNOVATIVE CURRICULUM DESIGN AND EXECUTION: AN INTERDISCIPLINARY TEAMWORK

My interdisciplinary collaboration, research direction and successful experience in launching various experiential learning courses at faculty of science have served as a solid foundation for me to develop an interdisciplinary “Science and Technology” module taught in the University Common Core Course “CCST9070: Inspiration from Nature”, which was met with immediate success and has created a wide impact in HKU's common core education for “interdisciplinary and innovation” among students from different faculties. At the end of this course (as shown in Figure 5), I was fascinated to see the extremely creative ideas for developing prototypes and product designs (although sometimes a bit too creative!) from students inspired by this hands-on project experience. Each group in the course was comprised of students from different/diverse discipline (science, engineering, and medicine) to extract their most fascinating and innovative inspiration.



8. EXPERIENTIAL EDUCATION WITH INTERDISCIPLINAR COLLABORATION: THE WAY FORWARD

After achieving the highest possible positive feedback and SETL scores for teaching and course effectiveness for over 25 courses from 100's of HKU students and also after consistently (10 years in a row) scoring A to A+ grade with outstanding achievement in teaching from two of my senior colleagues through HKU's PRD process, I feel accomplished to a large extent. I also feel that I have achieved some of my main goals in teaching, i.e. inspire students to be enthusiastic learners who are excited about experiential learning from field-based and research-lead education and see novel pathways for using science in their future career as young entrepreneurs. My learning process and international engagement reflect the true nature of a teaching career, which is in fact a life-long learning journey. Therefore, I am continuing to learn new knowledge and incorporate them back into our teaching activities. Without the learning element, there will be no new life for teaching development. Without our community and peers to assist us assessing the quality of our teaching, it is not likely for us to see our own shortcomings, let alone to realize what strategy is needed to reach a new height in experiential learning education with interdisciplinary components.

Development and execution of a comprehensive experiential education for ALL science students is one of the major parts of my teaching career and ambitions. While I have been thoroughly enjoying my role in the faculty of science as assistant dean for experiential learning, I'm also determined to successfully implement various new schemes, e.g. P2P@HKUscience and student experiential learning ambassadors, to meet the HKU's goal of 100% mainland and overseas experience for ALL science students by 2022.

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