Science Faculty Office

Tel: 3943 6250 / 3943 6185
Fax: 2603 5156
Address: Room G43, Science Centre North Block,
The Chinese University of Hong Kong
Website: *http://www.cuhk.edu.hk/sci*

Centre for Promoting Science Education

Tel: 3943 1387
Fax: 2603 7693
Address: Room 325, Science Centre North Block,
The Chinese University of Hong Kong
Website: *http://www.cuhk.edu.hk/cpse*

Programme Website: *http://www.cuhk.edu.hk/sci/qef-s34*

香港中文大學 THE CHINESE UNIVERSITY OF HONG KONG

優質教育基金 Quality Education Fund

Science CUHK

CENTER FOR PROMOTING SCIENCE EDUCATION Faculty of Science, CUHK

A Science Enrichment Programme for S3-4 Students
Teaching and Learning Resources

Faculty of Science,
The Chinese University of Hong Kong

A Science Enrichment Programme for S3-4 Students

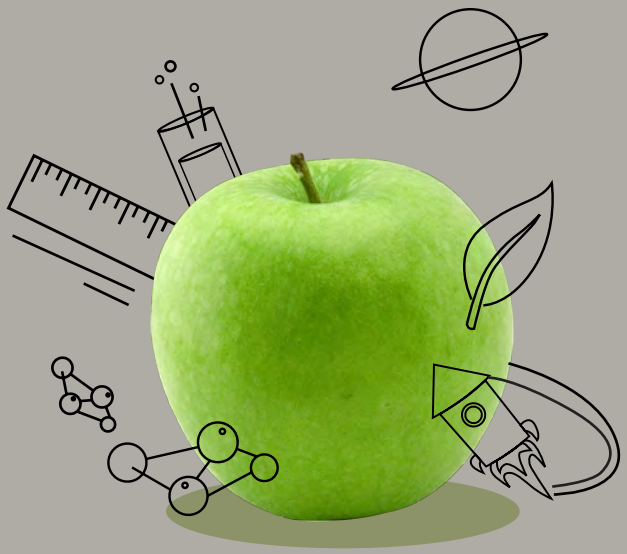
Student Version

Teaching and Learning Resources

by

A Science Enrichment Programme for Secondary 3-4 Students

ISBN 978-988-99692-5-7



It is Our Mission to Promote Science Education

Centre for Promoting Science Education
Faculty of Science, The Chinese University of Hong Kong

Preface

This book collects materials developed by the Faculty of Science at The Chinese University of Hong Kong for the project entitled *A Science Enrichment Programme for Secondary 3-4 Students (S3-4 Programme)*. The three-phase multidisciplinary programme for gifted students was supported by the Quality Education Fund.

The programme started with *Phase 1 – Scientific Workshops*, in which students participated in various learning activities, such as visits, demonstrations, and games, to acquire a broad-range of scientific knowledge. *Phase 2 – Intensive Workshops* then offered students a series of intensive training workshops in fields of their interest. *Phase 3 – Scientific Research* required students to put their knowledge into practice and conduct scientific research in groups of three to four under the supervision of teachers from the Faculty. A symposium was held for students to showcase and present their research findings using both oral and poster presentations. The learning activities of the programme were specially designed under a holistic framework to align with the desired learning outcomes, which included not only disciplinary knowledge but also generic skills, such as critical thinking and creativity, as well as the development of proper attitudes and values. Given the programme's success, the Faculty and the Centre for Promoting Science Education (CPSE) are now sharing the teaching and learning materials with teachers and students to contribute to the development of science and gifted education.

The collection consists of 4 books including a student's edition and a teacher's edition (the Chinese and English versions of each edition are published separately) and an accompanying CD. Each book has twelve chapters covering different topics that can be broadly classified into biology, chemistry, mathematics and physics. The objective is to help teachers to teach and students to learn a series of practical and interesting topics in the sciences.

The student's edition is specially arranged for self-learning. The concepts of the topics are illustrated with detailed examples in the *Learning Material*. Guidance is given in the exercises and discussion questions are included to guide students to learn independently.

Each chapter of the teacher's edition features several sections that lead teachers in facilitating student learning. *Suggested Student Work* and *Solutions and Activity Guidelines* help teachers accomplish an interactive lesson, and the *Assessment Guidelines* suggests parameters for designing appropriate assessment. The framework provides teachers with a clear outline of teaching a specific topic while leaving much room for them to explore their own teaching methods.

Apart from this collection, in March 2010 the Faculty and CPSE also published a set of instruments to share our experience in the S3-4 programme for identifying gifted students, entitled *Identifying Gifted Science Students: Practical Instruments*. It is hoped that the two collections of materials will contribute to nurturing students' interests in the sciences and developing their potential to the fullest.

Centre for Promoting Science Education
Faculty of Science, The Chinese University of Hong Kong
August 2011

Contents

A Science Enrichment Programme for Secondary 3-4 Students

Teaching and Learning Resources

Student version

Subjects

Message from the Dean

For many years, the Faculty of Science at The Chinese University of Hong Kong has been actively involved in the development of science teaching programmes for gifted students, a prime example of which is the *Science Enrichment Programme for Secondary 3-4 Students*. This effort was supported by the Quality Education Fund and is consistent with our aspiration of enhancing the quality and effectiveness of the education system in Hong Kong by introducing advanced and modern teaching curricula in science subjects to local secondary schools.

The publication of this book in both English and Chinese for secondary school teachers and students represents the most recent accomplishment of our Faculty as part of that effort. The book consists of 12 chapters, covering selected topics in Biology, Chemistry, Mathematics and Physics. Most of the materials included in the chapters are currently taught in undergraduate programmes of world-class universities. After reading this book, I am convinced that my colleagues have not only succeeded in conveying the essential ideas of these topics for high school students, but will also motivate them to pursue careers in science. In addition to emphasizing the fundamental insights of the topics without the use of advanced theories, examples of real-world applications are provided to help students consolidate their theoretical knowledge. It would be greatly beneficial to students if these materials were to be considered for incorporation into the senior secondary science curriculum in the near future.

I have the pleasure on behalf of the Faculty of Science of thanking the Quality Education Fund for its generous support. With this continuing partnership, we are sure that many more meaningful and fruitful projects will be developed to help modernize the high school science curriculum in Hong Kong.

Professor Cheuk-Yiu Ng
Dean of Science
The Chinese University of Hong Kong
August 2011

Message from the Project Leader

The publication of this collection of teaching and learning resources as well as the launch of *A Science Enrichment Programme for Secondary 3-4 Students* signify the commitment of the Faculty of Science and the Centre for Promoting Science Education (CPSE) of The Chinese University of Hong Kong (CUHK) to promoting science education. Amid the intense preparation within the University for the change from a 3-year to a 4-year curriculum in 2012 and stakeholders' growing expectations of university teaching and research quality, this programme gained massive support from professors and colleagues in the Faculty of Science. Teachers sacrificed their spare time to review wide ranges of reference materials to design various courses and learning activities that best suited the needs of the students, teach the courses in person, and supervise students to conduct scientific research in small groups, offering them opportunities to experience the scientist's life. The dedication and unyielding effort of the teachers brought about the success of the programme, which was widely popular among students. With their boundless enthusiasm for science and teaching, the teachers also served as excellent role models. I would like to express my gratitude to all team members for their strong support and their unrelenting effort. I feel much obliged to all of those who also spent an enormous amount of time preparing this collection of resources, which will help us share our work with the many secondary school teachers and students who did not have the opportunity to participate in the programme.

Throughout the entire process of organizing the Enrichment Programme and developing this collection of materials, we enlisted and enjoyed the full support of the Centre for Learning Enhancement and Research (CLEAR) at CUHK, the Quality Education Fund, the Gifted Education and Science Sections of the Curriculum Development Institute of the Education Bureau, and principals and teachers from many secondary schools. Not only did they give strategic suggestions for development of the programme, but they also provided valuable feedback on the course content, learning activities, assessment approaches, and many other dimensions. The feedback together with the systematic evaluation provided by CLEAR allowed us to make timely adjustments and continuous improvements within the project period, which enhanced the overall quality of the programme and the deliverables. On behalf of the project team members, I would like to extend my sincere thanks to all of them. I very much hope that in the future we can continue to join hands in a concerted effort to promote science education.

Professor Poon Wai Yin
Project Leader
Associate Dean (Education) of Science
The Chinese University of Hong Kong
August, 2011

‘A Science Enrichment Programme for Secondary 3-4 Students’
Project Team

Project Leader	Professor Poon Wai Yin Associate Dean (Education), Faculty of Science, CUHK
Deputy Project Leader	Professor Chan Hon Fu Raymond Professor, Department of Mathematics, CUHK
	Professor Kwan Hoi Shan Professor, Department of Biology, CUHK
	Professor Ng Kee Pui Dennis Professor, Department of Chemistry, CUHK
Evaluation Team	Professor Carmel McNaught Professor of Learning Enhancement, Center for Learning Enhancement And Research, CUHK
	Professor Lam Lai Chuen Paul Assistant Professor, Center for Learning Enhancement And Research, CUHK
	Mr. Lam Shun Leung Research Assistant, Center for Learning Enhancement And Research, CUHK
	Mr. Yeung Siu Sing Antony Research Assistant, Center for Learning Enhancement And Research, CUHK
Disciplinary Coordinators/ Course instructors	Professor Chan Ho Yin Edwin Associate Professor, School of Life Sciences, CUHK
	Professor Chan Hon Fu Raymond Professor, Department of Mathematics, CUHK
	Dr. Chan Wing Fat Senior Instructor, Department of Chemistry, CUHK
	Professor Cheung Chi Keung Peter Associate Professor, School of Life Science, CUHK
	Dr. Cheung Leung Fu Senior Instructor, Department of Mathematics, CUHK
	Professor Cheung Siu Hung Professor, Department of Statistics, CUHK
	Dr. Chow Cheung Ming Instructor I, School of Life Science, CUHK

Disciplinary Coordinators/ Course instructors	Dr. Chung Kwok Cheong Instructor I, Department of Biology, CUHK
	Dr. Fung Yin Wan Wendy Research Assistant Professor, Faculty of Science, CUHK
	Professor Hui Pak Ming Professor, Department of Physics, CUHK
	Professor Kong Siu Kai Professor, School of Life Sciences, CUHK
	Dr. Mak Kin Wah Kendrew Senior Instructor, Department of Chemistry, CUHK
	Miss Ng Yuk Fan Research Assistant, Food Research Centre, CUHK
	Professor Ong Hock Chun Daniel Associate Professor, Department of Physics, CUHK
	Dr. Pang Kam Moon Instructor, Department of Physics, CUHK
	Professor Poon Wai Yin Professor, Department of Statistics, CUHK
	Dr. Tong Shiu Sing Senior Instructor, Department of Physics, CUHK
	Professor Tsang Wei Kei Paul Research Assistant Professor, School of Life Sciences, CUHK
	Dr. Wong Chak Fu Jeff Instructor I, Department of Mathematics, CUHK
	Miss Yip Pui Sze Instructor II, School of Life Science, CUHK
Secretariat	Ms. Lam Chuk Wan Jorine Administrative Assistant, Science Faculty Office, CUHK
	Miss Lee Wing Sze Cecilia Project Coordinator, Science Faculty Office, CUHK
	Miss Cheung Wun Yin Vanessa Project Coordinator, Centre for Promoting Science Education, CUHK

Secretariat	Miss Leung Pik Ying Joyce Project Coordinator, Centre for Promoting Science Education, CUHK
	Miss Leung Siu Ki Jay Project Coordinator, Centre for Promoting Science Education, CUHK
	Miss Lung Ka Ying Kaye Project Coordinator, Centre for Promoting Science Education, CUHK
	Miss Chan Yi Ling Tobey Graphic Illustrator, Centre for Promoting Science Education, CUHK
Advisory Board	Ms. Chung Oi Lin Irene Senior Curriculum Development Officer (Science), CDI, EDB
	Mr. Fong Wai Hung Raymond Senior Curriculum Development Officer (Science), CDI, EDB
	Dr. Fung Sun Wai Leo Senior School Development Officer (SBCDS),QAD, EDB
	Dr. Lau Yiu Hon Curriculum Development Officer (Science), CDI, EDB
	Mr. Lee Pak Leung CQAO, QAD, EDB
	Mr. Leung Kin Tak Joseph Curriculum Development Officer (Gifted Education), CDI, EDB
	Ms. Lui Mong Yu Grace Senior Curriculum Development Office (Science), CDI, EDB
	Mr. Wong Chung Po Senior Curriculum Development Office (Gifted Education), CDI, EDB

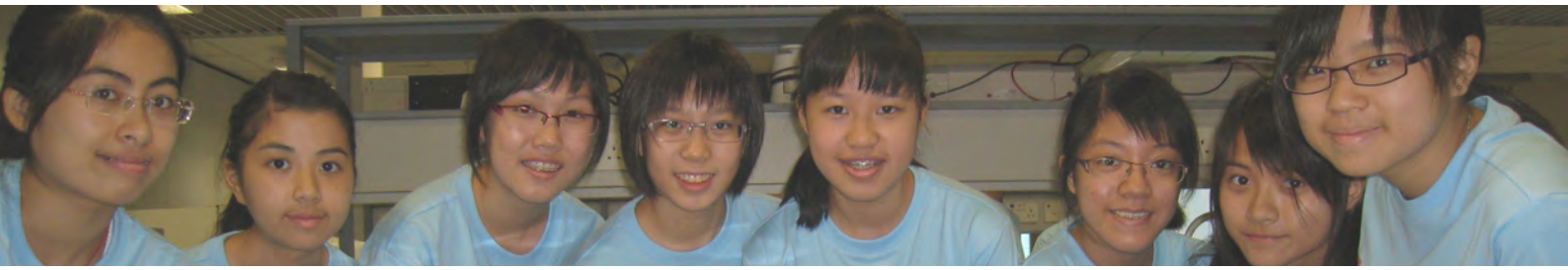
Acknowledgements

The project entitled *A Science Enrichment Programme for Secondary 3-4 Students* (September 2008 to August 2011) was sponsored by the Quality Education Fund. Members of the project team and the Faculty of Science at The Chinese University of Hong Kong would like to express their gratitude to the Quality Education Fund, the Gifted Education Section and the Science Education Section of the Curriculum Development Institute of the Education Bureau, and the following individuals for their invaluable support.

Individuals (In Alphabetical Order)

Name	Institution
Mr. Chan Chiu Kwong	Lee Kau Yan Memorial School
Mr. Chan Yu Nang	Lee Kau Yan Memorial School
Mr. Cheung Chun Hung	Sir Ellis Kadoorie Secondary School (West Kowloon)
Mr. Cheung Man Fung	Lee Kau Yan Memorial School
Mr. Cheung Ngan	Heung To Middle School (TSW)
Mr. Chiu Seen Hang	Sha Tin Government Secondary School
Mr. Fung Man Keung	Sir Ellis Kadoorie Secondary School (West Kowloon)
Mr. Fung Tak Wah	Queen Elizabeth School Old Students' Association Secondary School
Mr. Leung Wai Ming	Sir Ellis Kadoorie Secondary School (West Kowloon)
Mr. Li Chun Man	Sir Ellis Kadoorie Secondary School (West Kowloon)
Mr. Liu Yin Chun	CNEC Lee I Yao Memorial Secondary School
Mr. Ronnie Yeung	Lee Kau Yan Memorial School
Mr. Shiu Ngai Ming	Hong Kong Tang King Po College
Mr. Siu Kai Wa	Fanling Lutheran Secondary School
Mr. Wong Man Pan	Heung To Middle School (TSW)
Mr. Yan Chun Keung	TWGHs Li Ka Shing College
Mr. Wong Ka Wa	Fanling Lutheran Secondary School
Ms. Chan Kam Sheung	Heung To Middle School (TSW)
Ms. Cheung Man Hing	Sir Ellis Kadoorie Secondary School (West Kowloon)
Ms. Dik Wai Yin	Law Ting Pong Secondary School
Ms. Fan Siu Fung	Po Leung Kuk 1983 Board Of Directors' College
Ms. Fu Wei Li	Hong Kong Tang King Po College
Ms. Ip Yee Tak	CNEC Lee I Yao Memorial Secondary School
Ms. Lam Shin En	Law Ting Pong Secondary School
Ms. Lam So Kam	SKH Li Fook Hing Secondary School
Ms. Law Wai Kwan	Cheung Chuk Shan College
Ms. Lee Wing Chi	Lee Kau Yan Memorial School
Ms. Tsang Sui Yin	Lee Kau Yan Memorial School
Ms. Tsui Kwan Yuk	HKSYCIA Wong Tai Shan Memorial College
Ms. Wong Wing Kei	China Holiness Church Living Spirit College
Ms. Yang She King	Notre Dame College

Overview of the S3-4 programme



The Science Enrichment Programme is supported by the Quality Education Fund and is specially designed for Secondary 3 students who exhibit a high degree of aptitude and enthusiasm for science and mathematics. The three-phase programme, covering a series of learning and training activities in the various sciences, provides students with the opportunity to explore and develop their higher order thinking skills, creativity and personal-social competences. It also nurtures students' multiple intelligences and fosters their all-round development in science.

Phase 1 is aimed at training students to tackle genuine science problems, focusing on applying, analyzing and evaluating the material studied. Phase 2 further enhances students' knowledge of science and begins to focus on the development of their metacognitive skills. Phase 3 then trains students to become independent and efficient learners by assisting them to engage in real research problems. In Phase 3 they are required to generate new ideas and to evaluate the applicability of their ideas. In so doing, each student should become more cognizant of his or her own learning style and respective strengths and weaknesses.

Objectives

- to explore students' unrealized academic potential;
- to enrich their knowledge of science and enhance their ability to use that knowledge;
- to enhance their communication skills in science; and
- to engender their interest. motivation and appreciation for the sciences.

Target Participants

- Secondary 3 students gifted in the sciences

Programme Content

- Scientific workshops and tutorials
- Thematic seminars and lectures
- Visits and fieldtrips
- Scientific workshops
- Group research

Length of Programme

Phase 1 (February to April 2009): 3 months
Phase 2 (July to December 2009): 6 months
Phase 3 (February to May 2010): 4 months

The Three Phases of the Programme

This was an 18-month programme with three study phrases.

Phase 1 (February to April 2009) - Scientific Workshops

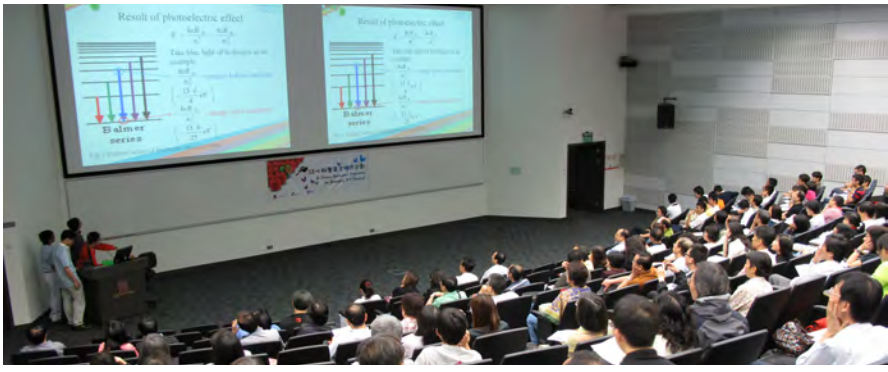
Participants were required to attend at least four out of six of the workshops, each of which lasted for six to eight hours. These workshops included lectures covering a wide range of topics in science (including biochemistry, biology and Chinese medicine, chemistry, mathematics, physics and statistics) presented by professors/staff at the Faculty of Science at The Chinese University of Hong Kong. Other activities, such as visits, laboratory demonstrations and science-related games, were also held to enhance students' scientific knowledge. Students were assessed after each workshop. The 120 students with the best performance in the four workshops were invited to join Phase 2 of the programme.

Phase 2 (July to December 2009) - Scientific Workshops & Intensive Courses

Students participated in two scientific workshops held in September 2009. Training and a series of experiments were organized to help prepare students for the upcoming intensive courses. In October and November, an intensive training course was provided to students who were at S4 level according to their chosen stream of specialization. Students were expected to attend the courses as well as various learning activities. At the end of these courses, students were assessed and the top 13 students of each stream were invited to join Phase 3 of the programme. In Phase 2 students selected from four subject courses: (1) biological sciences, jointly offered by the Department of Biochemistry and the Department of Biology; (2) chemistry, offered by the Department of Chemistry; (3) mathematical sciences, jointly offered by the Department of Mathematics and the Department of Statistics; and (4) physics, offered by the Department of Statistics.

Phase 3 (February to May 2010) – Scientific Research

Phase 3 provided students with research opportunities and the chance to put theory into practice. It commenced with lectures on laboratory safety and basic research skills and concepts. Supervised by CUHK teaching staff, students were required to conduct research projects on subjects of their choosing in groups of three to four, and they presented their research studies at a symposium.



Useful Links

A Science Enrichment Programme for Secondary 3-4 Students
http://www.cuhk.edu.hk/sci/qef-s34

Case-based Learning of High School Science Subjects
to Support Learning to Learn
http://www.cuhk.edu.hk/sci/case-learning

Centre for Promoting Science Education at
The Chinese University of Hong Kong
http://www.cuhk.edu.hk/cpse

Faculty of Science at The Chinese University of Hong Kong
http://www.cuhk.edu.hk/sci

Education Bureau, HKSAR
http://www.edb.gov.hk

Quality Education Fund
http://qef.org.hk