1. Final report

Project No. 2011/0158
Project Title: Development of experiments on radiation and radioactivity and sharing of education materials through a Wiki-style electronic platform 開發有關核輻射及放射性的實驗及使用維基式電子平台共享教材

(i) Attainment of objectives

The following goals and objectives listed in the original proposal have been attained.

- Experimental establishments for the teaching of radioactivity
  - Two experiments were set up for demonstrating *inverse square law of nuclear radiation* and *attenuation of the intensity of radiation passing through an absorber* (made of paper, aluminum, steel or lead). Both of them involve the use of radioisotopes. They also involve the use of a GM counter or survey meter to detect the intensity of nuclear radiation, and removal of background radiation from a reading. The students learned how to prevent excessive exposure of nuclear radiation; handle and store a radioisotope safely; and assess the safety level of a nuclear radiation experiment.
  - Five dry ice-free cloud chambers were fabricated for the use of illustrating ionization of gas molecules by nuclear radiation particles. Very weak radioactive sources were used in the experiment. The students were instructed to perform do-it-yourself experiments for observing ionization tracks. Each cloud chamber is equipped with a camera for demonstrating the phenomena to a group of students in a classroom.
- Preparation and collection of documents and links for the teaching of radioactivity
  - A comprehensive article was prepared to explain the units of intensity and dose of nuclear radioactivity. Examples are given to demonstrate how to evaluate the safety level of a location or foods possibly affected by some radioactive substances.
  - Lab manuals of the experiments and the operation guide of the cloud chamber were prepared to describe the physical principle of the phenomena and the procedures of the experiments.
  - Official references and links for helping teachers and/or technicians to get the approval of using radioisotopes in their schools for teaching radioactivity are collected.
  - Links of on-line education materials for teaching radioactivity of many educational and official parties are compiled.
- Dissemination of the education materials through a website
  - References describing the Creative Common (CC) registration process are collected and uploaded to the CoWIN website.
  - All the above mentioned articles, literature creations, links and videos recording the activities in the workshops/seminars are uploaded to the CoWIN website.
- Workshops and seminars were carried out to disseminate the above materials to teachers and students. Students saw the demonstrations and gained the experience in operating the cloud chambers themselves. We also gained the experiences in organizing the activities.

(ii) Project impact on learning effectiveness, professional development and school development

We summarize the possible long-term impacts of this project in the following.

- An intangible achievement is to build up a connection between PolyU and many schools, such that the teachers from the parties can discuss how to promote the quality of education for school children. The university can utilize the expertise of her academic staff members to organize and offer practical trainings, which are not quite conveniently to be carried out in a school environment.
- The use of the dry ice-free cloud chambers allows the students to directly see the effect of radiation ionization in a classroom environment, instead of merely seeing the hard printed photographs of ionization tracks in a textbook. This helps to promote their interest and effectiveness of study.
- The intellectual properties and copyrights of literature creations are hardly preserved if they are propagated through electronic media like internet due to the ease of copying. The implementation of Creative Common registration in this project could be a way to alleviate this problem and helps in the run long to popularize electronic education. Creative Common registration helps preserve the author's information through the registration system. The use of a Wiki-style CoWIN e-platform in disseminating the materials in the project helps to popularize the use of an electronic platform for education purposes.
- In the long run, the project contributes to build up correct scientific concept on nuclear radiation for some public members and to diminish unnecessary panics in the society when any nuclear accidents occur in the future.

(iii) Cost-effectiveness – a self-evaluation against clear indicators and measures

We collected the feedbacks of the students and teachers attending the activities through questionnaire survey to reflect the cost-effectiveness of the project.

- Appendix 1 is the questionnaire used to collect the feedbacks from the students attending the activities. Appendix 2 is the questionnaire used to collect the feedbacks from the teachers. Both of them were presented in Chinese. The questions for students collect the opinions on how the content of the workshops helps them to deepen their understanding on radioactivity; and their opinions on the arrangement of the workshops, presentation skills of the instructors and their intention to recommend similar activities to other students/friends etc. The questions for teachers collect their opinions on the degree of relevancy of the content to the syllabus of Physics of the secondary school curriculum, and the effectiveness of helping them in teaching the topic etc.
- Appendix 3 (Table 1) shows the statistics of the feedbacks from the students.
- Appendix 4 (Table 2) shows the feedbacks from the teachers who helped coordinate their students to attend the activities.
- Appendix 5 (Table 3) shows the summary of the analysis of the data. In brief, 463 students joined the activities, namely the workshops and seminars. 67 questionnaires were completed by representative participants. Most of them agree the design and arrangement of the activities. In addition, we lent the dry ice-free cloud chambers to a school. Now, the setups are stored in PolyU and are available anytime for more schools to borrow for teaching.

Appendix 1 : Questionnaire (for students)
核輻射工作坊學生問卷 (QEF/2011/0158)

	非常同意	同意	不同意	非常不同意
工作坊加深了我對核輻射課題的認知和／或興趣				
我贊同工作坊的設計和安排				
工作坊導師講解清晰				
我有足夠的空間提問				
我會推薦其他朋友參與此工作坊				
我希望日後能再參與這類工作坊				

意見：

Appendix 2 : Questionnaire (for teachers)
核輻射工作坊老師問卷 (QEF/2011/0158)

	非常同意	同意	不同意	非常不同意
工作坊跟中學新高中物理課程相關				
工作坊加強了學校在相關課程上的教與學				
工作坊能協助老師，減低提供核輻射實驗的壓力				
工作坊加深了學生對核輻射課題的認知和／或興趣				
學生在工作坊有足夠的空間提問				
我會推薦其他學校參與此工作坊				
我希望學生日後能再參與此類工作坊				
我支持舉辦這類工作坊				

意見：

Appendix 3 (Table 1) A summary of the statistics of the feedbacks from students.

Questions for students	Results from valid completed questionnaires (59)
	Numbers of students selecting "非常同意" and"同意"
工作坊加深了我對核輻射課題的認知和／或興趣	100%
我贊同工作坊的設計和安排	100%
工作坊導師講解清晰	97%
我有足夠的空間提問	92%
我會推薦其他朋友參與此工作坊	97%
我希望日後能再參與這類工作坊	98%
Other comments from students: • 希望可以內容較淺 • 很有趣 • 很有趣（詩的部分也很好） • 可學懂有關輻射的安全知識 • 希望工作坊提問時間增高 • 讓其他學生都能參加 • 此課堂生動有趣 • 完美 • 工作坊的趣味性充足 • 如果還可以有這類型大點活動，就可以啦！另外在香港對輻射的認知都是不足 • 安排更長的時段讓我們參觀 • 時間希望更充裕 • 時間不充裕 • 講解可否教淺易明白？部分學生未必完全明白內容 • 時間可更長 • 工作坊參觀時間不足 • 講解輻射對人體的影響的公式可能對我們沒實際用處，建議多講輻射的特性／其他輻射源 • 希望可以參觀更多儀器，並且加長時間做實驗 • 輸入衰變數據環節較沉悶 • 若能嘗試更多的實驗，會更有興趣 • 時間不足 • 想試下 GM Tube，想有更多時間做實驗 • 希望有更多時間進行活動 • 希望可以多D野玩	

Appendix 4 (Table 2) A summary of the statistics of the feedbacks from teachers.

Questions for teachers	Results from valid completed questionnaires (8)
	Numbers of students selecting "非常同意" and"同意"
工作坊跟中學新高中物理課程相關	100%
工作坊加強了學校在相關課程上的教與學	100%
工作坊能協助老師，減低提供核輻射實驗的壓力	100%
工作坊加深了學生對核輻射課題的認知和／或興趣	100%
學生在工作坊有足夠的空間提問	100%
我會推薦其他學校參與此工作坊	100%
我希望學生日後能再參與此類工作坊	100%
我支持舉辦這類工作坊	100%
Other comments from teachers: • half-life 計算太深，可討論 random decay 與 half-life 的關係 • 以小組形式進行，互動性高，能誘發同學多發問，加深對課題的理解 • 同學期待能有更多實驗能親身進行 • 建議增加模擬實驗 • 希望能安排全級同學同去，以配合整體教學	

Appendix 5 (Table 3) Analysis of the survey results reflecting the effectiveness of the project.

Item	**Achievements**
Number of participants	463
Summary of questionnaire survey	• 67 completed valid questionnaire • 98% participants hope to have the chance to join similar workshops • 100% of the participants agree the and design and arrangement of the workshops, reflecting that the content of presentations, experiments and equipment fabricated for the workshop are greatly appreciated.
Loan of equipment (cloud chamber)	The cloud chambers were lent to schools for several times. They are now stored in a room in PolyU, and are ready to be lent to schools for learning and teaching purposes.

(iv) Deliverables and modes of dissemination; responses to dissemination

More details of the deliverables derived from the projects are presented in the part of "Deliverables". They are highlighted briefly in this section.

- Education packages for supporting the learning and teaching of radioactivity. They include the following items.
  - Articles and links describing how to get the approval of using radioisotopes in teaching activities in a school.
  - A comprehensive article introducing the units of radioactivity and dosage. The article shows examples of assessing the safety level of a location or foods possibly contaminated by radioactive substances, and that of the design of a radioactivity experiment.
  - Two experiments were set up for demonstrating *the inverse square law of radiation* and *attenuation of nuclear radiation passing through an absorber*. The experiments demonstrate the physical phenomena, the method for measuring the radiation intensity of a radioisotope using a GM counter or a survey meter; the method for handling and storing a radioisotope safely and the precautions for handing a radioisotope etc.
  - Five dry ice-free diffusion cloud chambers for demonstrating ionization of air molecules by radiation particles were assembled. They are available by outside educational institutions for teaching purposes.
- Documents and links describing the procedures of Creative Common (CC) registration are created.
- The abovementioned experiments and setups were used in the activities. More details are described in the next section.
- Documents including manuals of the abovementioned experiments, operation guide of the cloud chamber, links, videos etc., were uploaded to a Wiki-style e-platform for dissemination. Details of the links are presented in the part of "Deliverables".

(v) Activity list

The activities organized and held in the project period are listed in Appendix 6 (Table 4). The activities were mostly conducted at PolyU. Each program includes a seminar, an experimental demonstration section in a laboratory of the Applied Physics Department, and a section for the students to perform hands-on practice using the cloud chambers. Other than students, there were teachers and Vice Principals from the supporting institutions to join. Some of them gave instant responses and comments to the speaker during the seminar and experiments. In particular, the partners of Ho Dao College requested to carry out the activities on their campus.

Appendix 6 (Table 4) A summary of the activities held in the project period.

Date	**Activity**	**Participants (both teachers and students)**	**Location**	**Number of participants**
27/4/2013	Seminars, workshops for experiment demonstrations and hands-on practice	College	PolyU	4

4/5/2013	Seminars, workshops for experiment demonstrations and hands-on practice	Secondary School	PolyU	24
2/7/2013	Seminar	College	College	302
5/7/2013	Seminars, workshops for experiment demonstrations and hands-on practice	College	PolyU	37
10/7/2013	Seminars, workshops for experiment demonstrations and hands-on practice	College	PolyU	38
22/7/2013	Seminars, workshops for experiment demonstrations and hands-on practice	Secondary School	PolyU	37
23/7/2013	Seminars, workshops for experiment demonstrations and hands-on practice	College	College	11

(vi) Difficulties encountered and solutions adopted

We did not find any difficulty in conducting the project.