優質教育基金
Quality Education Fund

M:FR/E

Final Report of Project	**Project No. :** **QEF/2013/0127**

Part A

Project Title: **Laboratory with no limits: AnyTime, Anywhere (Real-time Access Remote Laboratory Platform for S4-6 students)**

Name of Organization/School: Department of Applied Physics, The Hong Kong Polytechnic University

Project Period: From 01/09/2014 *(month/year)* to 30/08/2016 *(month/year)*

Part B

*Please read the **Guidelines to Completion of Final Report of Quality Education Fund Projects** before completing this part of the report.*

See Attachment

Name of Project Leader: _____ Name of Grantee*: _____

Signature: _____ Signature: _____

Date: 30/9/2016 Date: 30/9/2016

** Final Report of Project should be submitted via "Electronic Project Management System" (EPMS). Once submitted, these reports are regarded as already endorsed by the supervisor of the school/the head of the organization or the one who signed the Quality Education Fund Agreement for allocation of grant on behalf of the organization.*

Attachment

Attainment of Objectives

In this project, three objectives have been proposed:

1) Promote an online education platform for secondary schools. This platform allows real-time access to remote controlled physics experiments for DSE syllabus:
2) Encourage IBL among secondary school students based on this platform
3) Evaluate the effectiveness of this education platform and compare it with other teaching means.

Table 1: Attainment of Objectives

Objective statement	Activities related to the objective	Extent of attainment of the objective	Evidence or indicators of having achieved the objective	Reasons for not being able to achieve the objective, if applicable
Objective 1	1) Platform with a total of six remote experiments and booking system were developed. 2)A workshop "NSS Enriching Knowledge Series of the Physics Curriculum: ***Web-based Remote laboratories for Learning and Teaching of Physics***" was held on 9th June, 2015 in Room TU201, The Hong Kong Polytechnic University	Fully achieved	1) The platform was used by many school teachers as well as students from at least ten different high schools. 2) The workshop had more than 80 school teachers and curriculum development officers from Science Education Section, Education and Manpower Bureau participated.	
Objective 2	A course was organized on 11 August, 2016. The students were student members from HKAGE.	80% attained	More than 30 students from different high schools (including local and international) joined the course. The students were from S4 to S6 levels. The course included 3 hours of lecture and 6 hours of remote experiments. The students performed the experiments on their own schedule. After the experiments, they needed to write experimental reports on the experiments. The feedbacks of the students were very positive.	
Objective 3	1) Participated in the Education Fair during 22-23 Jan, 2016 in the Grand Hall, Convention Centre 3, Hong Kong Science Park	95% attained	1) The setup of the remote interference experiment was displayed in the Fair and more than 50 teachers from different schools showed interests in the remote laboratory project	

	2) Questionnaires were given to different high school users for feedbacks.		2) The feedbacks from both the high school teachers and students found that the platform is very helpful as some of the experiments cannot be performed in class.	

Project impact on learning effectiveness, professional development and school development

In this project, a remote experimental platform was developed. This platform allows students to do experiments anytime and anywhere. In the first stage, three experiments (Interferene, Magnetic and Radiation) were developed. A workshop was then organized and the platform was introduced to the high school teachers in the workshop. During the workshop, a forum was organized to collect suggestions/comments from the high school teachers. Two remote experiments (namely, ultrasound and photoelectric effect) were suggested to be built by some teachers as well as members of science education sections, Curriculum Development Institute (CDI), Education and Manpower Bureau (EMB). In the next few months, the two suggested experiments-Ultrasound and Phototelectric Effects were built. Furthermore, on top of the five experiments suggested in the proposal, an additional remote experiment - the "charge-mass ratio of electron measurement" was also developed. This experiment is an advanced physics experiment used to find the electron's charge/mass ratio. As a result, totally six remote experiments were developed in this project. For each experiment, apart from the hardware, laboratory manuals (in both English and Chinese) and related teaching materials were made available to students as well as teachers.

Based on this platform, the high school teachers can use the developed experiments as either additional experiments for their students to perform at home individually or demo-experiments to be performed in-class. The platform allows students conduct the experiments more than once and obtain better results. Furthermore, the remote setup in this platform provides students a safe and low risk environment to perform the experiments, for example the radiation experiment.

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

Within the first one and half year, the setups of the five experiments (interference, magnetic field, radiation, photoelectric effect and ultrasound) were developed and the platform with a booking system for students was built. The stated objective for the first and half year was fully attained. In the last six months, one more experiment (totally six experiments, including the charge-mass ratio of electron measurement instead of five experiments as stated in the original proposal) was developed Then we launched the six experiments, to the five partner schools as well as other schools (including Lui Cheung Kwong Lutheran College, SKH Kei Hau Secondary School, YLPMSAA Tang Siu Tong Secondary School, Pui Ching Middle School, CCC Yen Ching College and TWGHs Wong Fut Nam College) for a full evaluation of the platform. Another workshop will be held around mid December, 2016 to introduce our platform including all six developed experiments again to more secondary school.

Table 2: Budget Checklist

Budget Items *(Based on Schedule II of Agreement)*	**Approved Budget (a)**	**Actual Expense (b)**	**Change [(b)-(a)]/(a) +/- %**
Staff and Student Helper	928,000	868961.61	-6.4%
Equipment	936,500	934,835.19	-0.2%
General Expense	69,760	49091.13	-29.6%

Deliverables and modes of dissemination; responses to dissemination

1. A central platform for performing remote-controllable laboratory session on six experiments (interference, radiation, magnetic field, photoelectric effect, ultrasound and charge-mass ratio of electron measurement), with a collection of equipment and the corresponding control consoles. Such setups will be made accessible to the teachers and students of the five partner secondary schools as well as several more schools. In this project, the platform including the booking system was built. The students can log into the system anytime/anywhere. In the platform, the hardware and the laboratory manuals (in both English and Chinese) of the six experiments (the five proposed experiments: interference, magnetic field, radiation, photoelectric effect and ultrasound, plus an additional experiment-the charge/mass ratio of electron measurement) were developed.

2. Supplementary L&T materials for the six experiments. These include background and supporting teaching materials, laboratory manuals, and websites with information relevant to particular experiments for both teachers and students. The detailed manual of the Ultrasound experiment is listed in the Upload Deliverables part.

Table 3: Dissemination Value of Project Deliverables

Item description (e.g. type, title, quantity, etc.)	**Evaluation of the quality and dissemination value of the item**	**Dissemination activities conducted (e.g. mode, date, etc.) and responses**	**Is it worthwhile and feasible for the item to be widely disseminated by the QEF? If yes, please suggest the mode(s) of dissemination.**

A central platform for performing remote-controllable laboratory session Supplementary L&T materials for the six experiments	1. Focus Group Interview Report (details see below) 2. Student Feedback Survey Introductory Workshop in Physics: Physics Remote Laboratory Workshop (SCIS1021) (details see below)	During 2016 summer, pilot run of Remote Lab was implemented in TWGHs Wong Fut Nam College. A focus group interview was conducted on 7 September 2016. 18 participants were invited and divided into two groups to comment and share their experience on Remote Lab. The results of the interview report are summarized below. Student Feedback Survey was conducted on 11 Aug 2016. 27 participants completed the survey with 23 items from 1 (Strongly Disagree) to 4 (Strongly Agree). The responses are summarized below.	Yes. Through Workshop organized by EMB

Summary of the Focus Group Interview Report

Advantages of Remote Lab

Participants were satisfied with the learning experience. 40% of interviewees agreed that the online guidance is clear, learning materials includes notes and demonstration videos are useful. Theory, procedure and setup are easy to understand and follow. About one-third of them appreciated the flexibility of the Remote Lab. They were able to access the laboratory anytime through internet even at midnight. Participants could conduct the experiment more than once and obtain better result. Moreover, they felt that the Remote Lab is safe to conduct with low risk, such as radiation and photoelectric effect.

Disadvantages of Remote Lab

However, there are some drawbacks. First, around 40% of them thought the user interface had to be improved i.e. more user-friendly. Webcam shown on the page could be larger and more viewpoints were needed. Quarter of them experienced the unstable connections of the webcam, which was not displayed sometimes. Second, few students thought that the content of some experiments was difficult and complicated such as radiation and earth magnetic field. It would be better if teachers can give instruction and explanation during/immediately after Remote Lab. Last, few students felt distant and unrealistic to perform experiments on the internet. They acquired higher satisfaction and achievement when they connected the experimental setup by themselves and their experimental skills could be enhanced more in traditional experiment.

Suggestion/Improvement of Remote Lab

Finally, participants provided valuable suggestion to improve Remote Lab. The most concern of them is the

content of experiment. One third of them denoted parts of experiment are difficult. They would be more interested if the experiment is modified to an easier level and matched with the DSE syllabus. Meanwhile, they suggested that the platform should provide an exit quiz after the experiment to check their concepts as well as experimental knowledge. For the user interface, they suggested to move the "login" button to another significant location. In order to exchange different idea and scientific concept, they suggested to have discussion forum or conducting the experiment with others i.e. group experiments at the same time. Additionally, adding more pictures and video to introduction and theory parts will make it more fun.

Conclusion

To conclude, Remote Lab is a good platform to demonstrate experiment that cannot be conducted in secondary schools, without the advanced apparatus and setup. This platform contributes in both learning and teaching, students do not only learn from the textbook, but also observe from the experiment.

Student Feedback Survey : Introductory Workshop in Physics: Physics Remote Laboratory Workshop (SCIS1021)

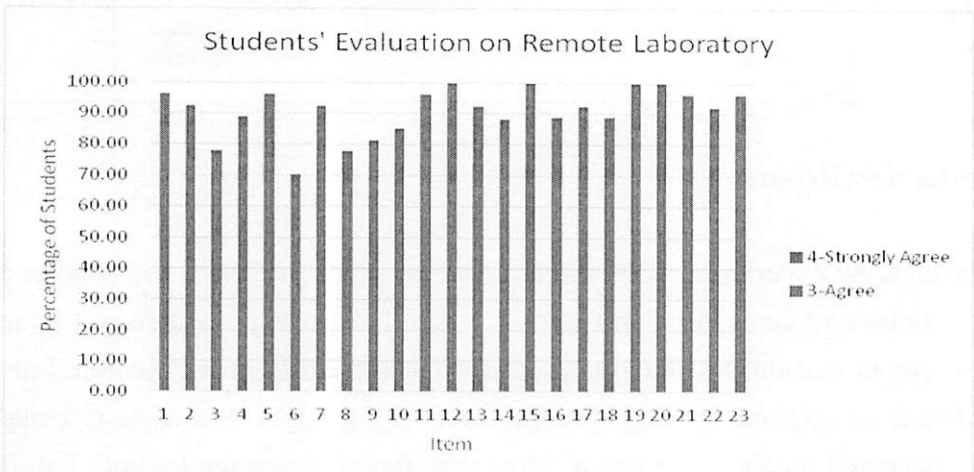

Fig. 3 Students' Evaluation on Remote Laboratory. The details of the survey question is at the end of this report.

Highest Scoring Items

As shown in Fig. 1, 70%-100% participants chose '3-Agree' and '4-Strongly Agree'; and none of them chose '1-Strongly Disagree' among 23 items. Three highest scoring items are questions 12 (M = 3.48, SD = 0.51), 17 (M = 3.35, SD = 0.49) and 9 (M = 3.33, SD = 0.48). 100% of participants agreed and strongly agreed the teacher is knowledgeable and professional (Q12); they want to learn more about this topic after studying this programme (Q17) and the order of presented content is appropriate (Q9).

Lowest Scoring Items

Three lowest scoring items are questions 3 (M = 2.78, SD = 0.58), 2ii (M = 2.81, SD = 0.48) and 6 (M = 2.85, SD = 0.45). As time is limited, a few topics could not be covered and interaction is relatively low. Around 30% participants disagreed that he/she was encouraged to express his/her creativity, e.g. express their ideas or seek the solution on their own (Q3). 22% participants disagreed that they were able to investigate the absorption of radiation in different materials and the inverse square law for gamma-radiation (Q2ii) and 19%

thought that they were not given time to interact with other peers and the teacher during class (Q6).

Further Comments

Besides the 23 standard items, 4 out of 27 participants provided suggestions and comments as below:

Suggestion:

- There can be more hands-on experience and interaction

Student Voice:

- It is funny to learn something outside the classroom. The apps is innovative.
- Quite Good!
- It gives us an insight into how remote experiments are like and their differences from virtual experiments.

Conclusion

To conclude, participants gave positive feedback and most of them were inspired and satisfied with the programme. They have tried something new and innovative, which enhanced their learning motivation. However, this programme can be enriched with more interaction with others and encouraging participants to express their creativity and critical thinking. Thus, they are able to apply knowledge efficiently.

Activity list

In this project, we have four main activities:

1) Development of a platform with a total of six remote experiments and booking system.
2) A workshop "NSS Enriching Knowledge Series of the Physics Curriculum: *Web-based Remote laboratories for Learning and Teaching of Physics*" was held on 9th June, 2015 in Room TU201, The Hong Kong Polytechnic University. Another similar workshop will be organized together with EMB in the coming December, 2016.
3) Participated in the Education Fair during 22-23 Jan, 2016 in the Grand Hall, Convention Centre 3, Hong Kong Science Park. The Education Fair was organized by Education Bureau & Hong Kong Science and Technology Parks Corporation
4) A course was organized on 11 August, 2016. The students were student members . More than 30 students from different high schools (including local and international) joined the course. The students were from S4 to S6 levels. The course included 3 hours of lecture and 6 hours of remote experiments. The students performed the experiments on their own schedule. After the experiments, they needed to write experimental reports on the experiments

Table 4: Activity List

Types of activities *(e.g. seminar, performance, etc.)*	**Brief description** *(e.g. date, theme, venue, etc.)*	**No. of participants**				**Feedback from participants**
		schools	teachers	students	others (Please specify)	

Development of a platform with booking system and six remote experiments	Sept, 2014 to Aug, 2016 Hong Kong Polytechnic University/ secondary schools	>10	>40	>600		More than 10 schools have asked their students to try this platform. The general feedbacks from the students are good
A workshop "NSS Enriching Knowledge Series of the Physics Curriculum: ***Web-based Remote laboratories for Learning and Teaching of Physics***"	9th June, 2015 in Room TU201, The Hong Kong Polytechnic University	>80	>80	Nil	members of science education sections, CDI,EMB.	The comments from the teachers are very positive.
Education Fair organized by Education Bureau & Hong Kong Science and Technology Parks Corporation	22-23 Jan, 2016 in the Grand Hall, Convention Centre 3, Hong Kong Science Park.		> 50 school teachersvisited our booth			The response from the participants are good
A course "Introductory Workshop in Physics: Physics Remote Laboratory Workshop ((t on 11 August, 2016.	11 August in Department of Applied Physics, Hong Kong Polytechnic University	>30		38		The students feedbacks are very positive

Difficulties encountered and solutions adopted

Nil