

## Use of Course-based undergraduate research experiences model to enhance research interest of Hong Kong health professional undergraduate students

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### **Abstract**

*It has not been easy to recruit postgraduate students from graduates of health professional programmes in Hong Kong. Recent studies show that Course-based undergraduate research experiences (CURE) not only promote students' acquisition of research abilities and collaboration skills, but also changes their career choices and attitude. In this study, we attempted to offer CUREs to students of the Medical Laboratory Science Programme in our institute as extra-curricular activities to arouse their interest in scientific investigations. Students participated in learning research methods and laboratory techniques. They also acquire hands-on research experience. The outcomes were evaluated with the CUREs Survey developed by Prof. David Lopatto of Grinnell College and focus group discussion. Results of the CUREs survey reveal that students obtain positive gains from the CUREs programme with the relevant learning experience. Similar to previous studies, CUREs participants develop content knowledge, confidence, research skills and confirm their interest in pursuing science-research related educational or career paths.*

**Keywords:** *Course-based undergraduate research experiences; health professionals programmes; educational and career paths.*

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## **1. Introduction**

Having competent researchers and graduates in health professional training is critical in strengthening the health systems and addressing priority health services. The major challenge in Hong Kong is the succession gap of researchers in various health professional disciplines, e.g. Medical Laboratory Science (MLS), Radiography and other allied health professions. The number of students pursuing postgraduate studies is low. One cannot rule out that an influential factor contributing to the situation comes from the attractive remuneration packages offered by hospitals and medical laboratories. According to an international career platform, the average starting salary for a fresh undergraduate of a health professional programme in Hong Kong almost doubles that of those graduates of all the non-health programmes. The scale is comparable to that offered to a post-doctoral fellow. The situation makes it almost impossible to get our undergraduates persuaded to postgraduate studies.

To nurture talents and encourage academic development, universities are trying different approaches. For example, our institute attempted to offer Summer Undergraduate Research Studentship and implemented an Undergraduate Research and Innovation Scheme to nurture the next generation of innovators by providing early hands-on experience in research. However, in most circumstances, only very few students with high grade-point-averages (GPA) benefited from this short duration of at most two months of close research mentorship via these programs. In addition, this one-on-one research guidance for all undergraduate students appeared impractical.

Recent studies demonstrated that Course-based Undergraduate Research Experiences (CUREs) effectively promote the research interest of undergraduate students by expanding the research element in the undergraduate curriculum and hence improving their attitudes towards scientific careers (Cooper & Brownell, 2018). CUREs is a type of scalable laboratory-learning environment. It works in engaging the whole class of students in a research question or problem of interest to the scientific community (Auchincloss et al., 2014). CUREs offer students opportunities in pursuing discoveries in their interests (Corwin et al., 2018). Mentors support dispelling uncertainties and solving problems (Light, Fegley, & Stamp, 2019). The CUREs model is well accepted in the Western. Universities have developed their respective CUREs in life sciences and chemistry in recent years (Krim et al., 2019; Van Dyke, Gatazka, & Hanania, 2018; Wang, 2017). Nevertheless, CUREs is still new to the curriculum in Hong Kong.

In this study, CUREs model is adopted as after-lecture activities in our courses. The aims of this project were to (1) convey lifelong learning techniques; (2) accentuate the importance of balancing collaborative and individual work; and most importantly (3) through increased chance and duration in research studies, we aim at developing students' scientific literacy skills, proscience attitudes and evidence-based decision-making abilities.

## **2. Methods**

This experimental study is faculty-based. First and second-year students of programmes in Medical Laboratory Sciences or Radiography who did not have previous similar training experience were eligible to participate. Academic performance, such as GPA (Grade point average), was not taken into consideration. In addition, unlike traditional practical sections and final year projects, procedures for investigations were not spelt out for the participants to follow. Rather than following prescribed manuals or procedures set by instructors in laboratory section, participants were asked to set their research questions, design, and implement their investigations. Guidance would be provided in special tutorials on research questions, hypothesis setting, data collection, analysis, interpretation and result communication.

The standard CURE survey designed by Prof. David Lopatto of Grinnell College was adopted for course evaluation. The questions in the pre-course questionnaire investigate participants' learning motives, experiences, attitudes and learning styles. They explicitly but intriguingly indicate the desirable attitude and merits in science learning although students may consider the alternatives. Questions also allow students to understand their capabilities in learning science and the context of the programme. The questionnaire collects feedback from participants on the following areas are: (1) Affective gains, such as increased interest and enjoyment of science; (2) cognitive gains, such as developing science practice skills and learning scientific content; (3) psychosocial gains, such as developing confidence in their ability to do science, increased scientific identity, and improved sense of belonging both at college and within the scientific community; and (4) potential career outcomes, such as clarifying whether they are interested in getting more involved in research or pursuing a research-related career, for better using of CUREs in our courses.

## **3. Results**

Two rounds of CUREs were run as after-class activities in the last academic year. Junior undergraduate students from our department were recruited. During the semester, under teachers' guidance, students work as a team to (1) develop their research hypothesis, (2) design the experiments, (3) repeat and improve the protocols if necessary, (4) analyze the data and (5) finally deduce some meaningful conclusions. The participant background, numbers and topics of CUREs studies are briefly summarized in Table 1.

**Table 1. Summary of our Round 1 and 2 CUREs studies**

| Round # Semester (Year) | Participants (Number) | Controls (Number)       | Topic of activity                |
|-------------------------|-----------------------|-------------------------|----------------------------------|
| Round 1 (2020/1)        | Year 2 MLS (14)       | Rest of classmates (43) | How to setup the COVID-19 tests  |
| Round 2 (2020/1)        | Year 1 MLS (7)        | Rest of classmates (43) | Accuracy of ovarian cancer tests |

Most of the students joined the CUREs out of interest. They wished to pick up some laboratory techniques from the CUREs programme, get a better understanding of science and acquire more hands-on research experience. They all possessed varied experiences on course elements and had been under pre-set structured context with predesigned aims and expected outcomes.

The post-course questionnaire captures the gains and benefits that students considered they have achieved. The key data obtained from CUREs survey from both Round 1 and 2 CUREs students are summarized in Table 2 and 3, respectively.

**Table 2. Summary of CUREs survey from our Round 1 study**

| Gain  | No or very small | Small | Moderate | Large | Very large |
|---|------------------|-------|----------|-------|------------|
| Understanding of how knowledge is constructed         | 0                | 36%   | 18%      | 36%   | 9%         |
| Understanding of how research is constructed          | 0                | 36%   | 18%      | 36%   | 9%         |
| Ability to read and understand primary literature     | 0                | 0     | 18%      | 55%   | 27%        |
| Ability to integrate theory and practice              | 0                | 0     | 36%      | 36%   | 27%        |
| Skill in interpretation of result                     | 0                | 0     | 36%      | 36%   | 27%        |
| Ability to analyze data and other information         | 0                | 0     | 27%      | 45%   | 27%        |
| Becoming part of learning community                   | 0                | 0     | 27%      | 27%   | 45%        |
| Understanding of how scientists work on real problems | 0                | 27%   | 36%      | 18%   | 18%        |
| Tolerance for obstacles faced                         | 0                | 0     | 27%      | 55%   | 18%        |
| Self-confidence                                       | 0                | 0     | 36%      | 27%   | 36%        |
| Clarification of career path                          | 0                | 0     | 0        | 64%   | 27%        |
| Confidence to be a teacher in science                 | 0                | 0     | 18%      | 55%   | 27%        |

Remark: n = 11, as three participants did not submit their responses. (78.6% response rate)

**Table 3. Summary of CUREs survey from our Round 2 study**

| Gain  | No or very small | Small | Moderate | Large | Very large |
|---|------------------|-------|----------|-------|------------|
| Understanding of how knowledge is constructed         | 0                | 16.7% | 16.7%    | 50%   | 0          |
| Understanding of how research is constructed          | 0                | 0     | 66.7%    | 33.3% | 16.7%      |
| Ability to read and understand primary literature     | 0                | 16.7% | 33.3%    | 50%   | 0          |
| Ability to integrate theory and practice              | 0                | 0     | 33.3%    | 50%   | 16.7%      |
| Skill in interpretation of result                     | 0                | 0     | 66.7%    | 16.7% | 16.7%      |
| Ability to analyze data and other information         | 0                | 0     | 33.3%    | 66.7% | 0          |
| Becoming part of learning community                   | 0                | 0     | 33.3%    | 66.7% | 0          |
| Understanding of how scientists work on real problems | 0                | 16.7% | 33.3%    | 33.3% | 16.7%      |
| Tolerance for obstacles faced                         | 0                | 0     | 33.3%    | 66.7% | 16.7%      |
| Self-confidence                                       | 0                | 16.7% | 33.3%    | 33.3% | 16.7%      |
| Clarification of career path                          | 0                | 16.7% | 66.7%    | 16.7% | 0          |
| Confidence to be a teacher in science                 | 16.6%            | 16.7% | 33.3%    | 33.3% | 0          |

Remark: n =6, as one participant did not submit her response. (85.7% response rate)

We also compared their performance in our course based on the continuous assignments, tests and final examinations with their classmates.

**Table 4. Summary of the performance of participants and their classmates in our course.**

| Round | Group            | Number | Average GPA |
|-------|------------------|--------|-------------|
| 1     | Participants     | 14     | 3.57        |
|       | Non-participants | 43     | 3.30        |
| 2     | Participants     | 6      | 3.39        |
|       | Non-participants | 43     | 3.83        |

The career choice of participants after graduation are summarized in Table 5.

**Table 5. The career choice of CUREs participants before and after the CUREs activities**

| Round | Year of Study | CUREs  | Response | Work | Graduate School |
|-------|---------------|--------|----------|------|-----------------|
| 1     | 2             | Before | 12       | 10   | 2               |
|       |               | After  | 11*      | 10   | 1               |
| 2     | 1             | Before | 7        | 6    | 1               |
|       |               | After  | 6*       | 6    | 0               |

Remark: \*One participants in did not response the post-questionnaire.

#### **4. Discussion and Conclusion**

To the best of our knowledge, this was the first CUREs study carried out in the universities of Hong Kong. Consistent with previous findings from the universities of Western countries (Beatty, Ballen, Driessen, Schwartz, & Graze, 2021; Connors et al., 2021), CUREs participants agreed that they have moderate to a very large gain in various areas.

- (1) Psychosocial gains - the participants agreed that they got confidence in their ability to learn and analyze data from new scientific studies initiated themselves (Table 2-3).
- (2) Intellectual gains - the participants also agreed that skills and knowledge in science as reflected by the data from the CUREs survey (Table 2-3). To have a more objective conclusion, we compared their academic results with non-participants; the CUREs participants had better academic performance than those of the non-participants (Table 4). However, here we need to point out that it may be due to selection bias.
- (3) Behavioral gains- the CURE survey was anonymous. The drop in the return of the post-course questionnaire makes it premature to conclude if the CUREs programme affects the career choice of participants after graduation. We consider the data recorded in Table 5 as an interim record. Up to the present stage, even though CUREs did not enhance the likelihood of participants going to graduate school in these two cohorts, it is encouraging that the participants agreed of getting a clearer picture of their career paths. They confirmed that the CUREs programme provided a better idea for research studies.

In summary, Year 2 students found more benefits from the CUREs programme than Year 1 students did. However, there were limitations to this study. Firstly, the sample size of this study was small. In addition, the participants all came from the Medical Laboratory Science programme, which might contribute to bias in the study. To have a better picture of the impact of CUREs on the Hong Kong health professional undergraduate students, we will explore the opportunity to carry out a bigger study in collaboration with other departments.

#### **Acknowledgments**

This study is supported by the Hong Kong Polytechnique University Teaching Development Grants 2019-22 (SS-HTI).

#### **Ethical approval**

This study (HSEARS20200826002) was approved by the institutional review board of the Hong Kong Polytechnique University.

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