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# Self-reported perception of a Dedicated research semester in Pharmacy curriculum in enhancing research competencies

Eng Lai Tan<sup>1</sup>, Sook Yee Gan<sup>1</sup>, Wei Meng Lim<sup>1</sup>, Peter C. K. Pook<sup>1</sup> & Vishna D. Nadarajah<sup>2</sup>

<sup>1</sup>Institute for Research, Development & Innovation, School of Pharmacy, International Medical University, Kuala Lumpur, Malaysia; <sup>2</sup>IMU Centre for Education, School of Medicine, International Medical University, Kuala Lumpur, Malaysia

## Abstract

This study measures the impact of the implementation of a dedicated research semester on various perceived competencies related to research. In 2016, surveys were conducted on final undergraduate Pharmacy students in regard to appraisal and critical thinking skills. Students' perceptions of the impact of research in enhancing their employment potential were investigated. Our evaluation included students' self-assessment of their writing, presentation, critical thinking and research skills. To assess qualitative parameters, the data obtained were analysed using the Wilcoxon signed-rank test. A total of 113 responses was received. A majority of students indicated that the research semester prepared them in undertaking their research projects. They acknowledged that research helped in building confidence and to acquire the ability to work independently. Most students perceived that the experience gained in research would enhance their employment potential. Overall, students developed critical thinking skills through their respective research project.

**Keywords:** Undergraduate Research, Pharmacy Programme, Critical Thinking, Research Ethics, Scientific Communication

## Practice Highlights

- Competencies from research projects need to be transparent to both students and supervisors.
- Diversity of research projects should reflect the different career pathways of pharmacists.
- Ethical and professional dilemmas from research projects is opportunity for reflective learning.

## I. INTRODUCTION

The Pharmacy profession has undergone tremendous changes over the years, and its scope has expanded. The roles of Pharmacists have extended beyond the traditional boundaries of drug preparation and distribution to ensuring that optimal therapeutic outcomes are achieved through patient-centred cognitive services (Bond, 2006; van Mil & Fernandez-Llimos, 2013). Pharmacists play increasing roles in patient education and counselling, health promotion and disease prevention, disease state management as well as being engaged in inter-professional consultation with other healthcare professionals in specialised patient settings

(Holland & Nimmo, 1999; Tsuyuki & Schindel, 2008). The new roles for pharmacists evolve in parallel with evidence-based medicine (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). Therefore, research skills are essential for both the practice and advancement of the pharmacy profession. In pharmacy, as in all undergraduate science programmes, research is a critical and essential component of the curriculum, although for pharmacy, being a professional degree, competency for practice takes precedence in the priority of the curriculum (Nykamp, Murphy, Marshall, & Bell, 2010). Nevertheless, there is a need to build a strong research program and culture within a pharmacy degree

curriculum through sustainable educational initiatives that complement rather than compromise competencies needed for practice. Research being a critical part of scholarship is necessary for inculcating the attributes related to professional competency such as creative and critical thinking as well as problem-solving. Moreover, research also improves student learning skills and encourages the pursuit of research-related careers (Banks, Haynes, & Sprague, 2009; Nykamp et al., 2010).

The implementation of research in pharmacy curricula varies between institutions. Many colleges and universities require students to undertake coursework in research methodology, biostatistics, drug information, and literature evaluation, but only a small fraction of them chose to complete an extensive project with data collection, analysis, and reporting research findings (Murphy, Peralta, & Kirking, 1999). However, increasing emphasis and proportion of time allocated for actual data collection and analyses over the years attest to the recognition of research experience in pharmacy training (Murphy, Slack, Boesen, & Kirking, 2007). Undergraduate or first-degree research training requires a supportive environment and intellectual partnership amongst students and their faculty mentors. Through research, these students are able to apply knowledge gained in the classroom as they define new problems and formulate new research questions (Ash Merkel, 2003). Incorporating research into the curriculum is important as a means of inculcating scholarship in the community of learning, to motivate undergraduates to become independent thinkers and to prepare students for graduate programs (Adamsen, Larsen, Bjerregaard, & Madsen, 2003). A study by Tan revealed that undergraduate students who were guided by suitable research mentors experienced improved thinking, communication, and interpersonal skills. They also manifested heightened levels of self-confidence, resourcefulness, goal-consciousness, creativity and responsibility towards others. These were in contrast to the general feeling of insecurity and uncertainty at the beginning of the research endeavour (Tan, 2007).

Investing in research is often regarded as a costly endeavour which involves dedicated time from faculty members (Nykamp et al., 2010). Furthermore, providing research opportunities for undergraduate students inevitably involves internal funding as well as the involvement of considerable time and proportion of the faculty member. Several major barriers to implementing undergraduate research have been reported. Among these include a lack of faculty members with appropriate expertise and sufficient time for research supervision; other major impediments include the lack of dedicated time for data collection, opportunities, funding, training

and support (Nykamp et al., 2010; Paalman, 2002). The logistics of managing research projects for a large number of students have been reported in some studies to be difficult or impossible. Universities have the option of eliminating laboratory experience from their undergraduate research project because of costs associated with maintaining laboratory personnel and the acquisition of expendable laboratory supplies and major equipment (Brandenberger, 1990).

Literature and contextual delivery of pharmacy programs across the world suggest the need to determine the impact of incorporating a research program for an undergraduate pharmacy curriculum (Awaisu & Alsaimy, 2015; Bunnett, 1984; Chopin, 2002; Doerschuk, 2004; Osborn & Karukstis, 2009; Warner, 1998). Will a semester dedicated to entirely research help students achieve the graduate competencies for the pharmacy profession through experiential learning? Hence, this study was conducted to evaluate the impact of a dedicated semester-long research program in an undergraduate pharmacy curriculum.

Before the commencement of the research semester, students select their research projects from a range of areas relevant to Pharmacy that include pharmacy practice, pharmaceutical technology, pharmacy chemistry and life sciences. These projects could be further categorised as laboratory-based, community-based or education research. Through the student mobility program and unique research partnership with other local and overseas institutions, students have opportunities to conduct their research projects in these external institutions. Students then defend their project proposals in the Research and Ethics Management Committee which ensures the quality, suitability and ethical aspects of a research project. In the Research Methodology module, students are given theoretical instructions in conducting a literature review, scientific writing and research ethics as well as training in statistics. The research semester spans a period of 16 weeks and should, therefore, be designed to provide an immersive experience in the rigours of research. This study measures the impact of the implementation of dedicated research semester on students' perceived competencies related to research writing, presentation and critical thinking skills, ethical knowledge and preparedness to undertake research.

## II. METHODS

This study is part of the regular programme audit conducted by the School of Pharmacy, the findings of which had been reported to the school's curriculum and examination committee for quality assurance purpose. Student feedback was sought from final year

undergraduate pharmacy students at the International Medical University in Kuala Lumpur, Malaysia in the second half of 2016. Students' participation was on a voluntary basis after informed consent was obtained and was also a part of the periodic curriculum assessment conducted by the School of Pharmacy. Feedback was obtained from students using an online questionnaire before and after the research project. The questions were developed to measure a student acquiescence of specific perceived competencies relevant to pharmacists as informed by the literature. The face and content validity of the questionnaire were conducted with a small cohort of undergraduate pharmacy students prior to the survey. The pre-research online questionnaire consisted of questions related to the nature, types and placement sites of the projects as well as factors affecting students' project preference. Ranking questions were also included for students' self-assessment of their writing, presentation, critical thinking and research skills. In addition, there were also open questions that solicit information pertaining to students' perceptions about their preparedness to undertake a research project, their knowledge about ethics in research and their anticipated career options. Where Likert-scale was used, the scores from each respondent were added up to achieve the final total. Wilcoxon sign-ranked test was used to compare all ranked data pertaining to students' perception of their competencies. The post-research survey consisted of similar questions found in the pre-research questionnaire but with an additional section on evaluating the impact of research projects that the students have undertaken. It contained questions to solicit students' perceptions on the enhancement of their knowledge in specific subject matter, the achievement of research objectives, the challenges they faced during the implementation of research project, skills developed and gained through the research project as well as the aspects of research ethics which are applicable to their future profession as pharmacists and the impact of research experience on their employment potential. All statistical tests were performed using SPSS Statistics and Microsoft Excel.

### III. RESULTS

#### A. Study Population

Out of 180 students, a total of 113 responses was received in surveys conducted prior to and after the commencement of their research projects in the year 2016. These students were supervised by academic staff from all the four departments of the School of Pharmacy, namely life sciences (31%), pharmaceutical chemistry (21%), pharmaceutical technology (10%), pharmacy

practice (22%) as well as the School of Dentistry (2%) and the School of Medicine (14%). Eighteen students were involved in community-based or education research while 95 students conducted lab-based research including those who were attached to other local institutions (eight students) or international partner universities (seven students) through collaborative research.

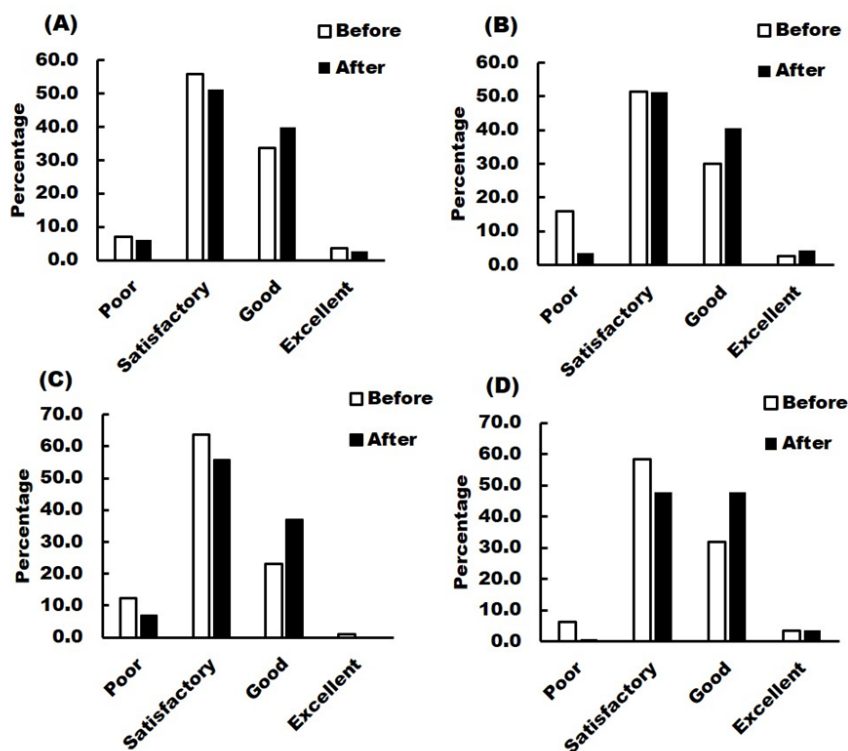
Most students of the cohort were successfully allocated to the project which was their first (61%), second (20%) or third choice (6%) although some (13%) were not allocated to the project of their choice. Interestingly, the main factor affecting the pharmacy students' preference was research interest (61%). Some students selected the project based on their choice of supervisors (19%), their peer's choice (10%) while other did not have a specific preference (10%).

#### B. Students' Ratings on Preparedness, Ethics Understanding, Writing and Presentation Skills

In quantitative measures, we evaluate the percentage distribution of student ratings before and after the implementation of research projects pertaining to preparedness to undertake a research project, understanding of research ethics, writing skill and presentation skill. For preparedness to undertake a research project, students are more prepared to undertake a research project in the future, the percentage rating for good had increased from 30.1% to 40.7% (Appendix). However, the frequency distribution of the outcome measures of students' preparedness after the project implementation was quite similar without any significant difference to before project implementation ( $p=0.472$ ) (Figure 1A).

Before the research project, approximately 32.8% of students rated themselves for having good and excellence understanding in research ethics. However, after the research project, the percentage has increased to 45.1%. Statistical analysis showed significant improvement for the understanding of research ethics ( $p=0.002$ ; Figure 1B).

There was 23.9% and 35.4% of students rated themselves for having good and excellent writing skill and presentation skill respectively. After the research project, the improvement is promising as the percentages had increased to 35.4% ( $p=0.001$ ; Figure 1C) and 51.3% ( $p=0.001$ ; Figure 1D) respectively.



Note: The ratings before and after project implementation were compared and statistically analysed using the Wilcoxon signed-rank test.

Figure 1. Percentage distribution of student ratings before and after the implementation of research projects pertaining to their

- (A) Preparedness to undertake research project (Mean value before=2.34, after=2.39,  $p=0.472$ );  
 (B) Understanding of research ethics (Mean value before=2.19, after=2.46,  $p=0.002$ );  
 (C) Writing skill (Mean value before=2.12, after=2.30,  $p=0.001$ ); and  
 (D) Presentation skill (Mean value before=2.33, after=2.54,  $p=0.001$ ).

### C. Students' Preparedness to Undertake a Research Project

Before the implementation of the research project, most students considered themselves well-prepared as they have improved their knowledge on the subject matter through personal reading and consultation with the respective supervisor (Table 1; Appendix A). They were well-informed about the research approach and techniques. However, these attributes were found lacking in those who have identified themselves as poor in preparation because they had less confidence and did not know what to expect. Students stated that they were now prepared to undertake research in the future because they have gained knowledge and exposure in research as well as trained with various laboratory and research skills (Table 1).

### D. Students' Self-Assessment of Their Writing and Presentation Skills

The surveys also considered students' self-assessment on their writing and presentation skills. Overall, there was a significant improvement in both skills after the implementation of the research projects. They have contributed their improvement to the reading of journal articles, writing and presenting the research proposal and dissertation. Moreover, students perceived that writing a scientific report was different from writing other reports

(Table 1). They found that it was challenging to discuss gathered information or results critically in a constructive manner as well as to ensure a good flow of content and clarity of the paper. As for presentation, some stated that stage fright affected their performance while others found that the question and answer section was quite challenging (Table 1).

### E. Students' Perceptions of Research Ethics

Students' perceptions of their understanding of research ethics are shown in Table 1. They have related unethical practices as manipulation of data, dishonesty in data reporting as well as lack of objectivity and confidentiality (Table 1). They described good ethical practices as fairness, accountability, peer respect, minimising harm as well as respect for human dignity and rights. Students were able to learn about ethics through their research projects (Table 1). However, some of them indicated that they might have sound ethical knowledge but found themselves inadequate to make decisions and were unsure about how to apply it. Students were, however, able to identify several aspects of research ethics which are applicable to their future profession as pharmacists. These professional values include honesty, informed consent, evidence-based practice, patient safety, confidentiality, punctuality, integrity, responsibility and respect for others.

Students' Comments		
	Before Undertaking Research Project	After Undertaking Research Project
Preparedness to undertake research	<ul style="list-style-type: none"> <li>• Done literature review and in the progress of writing proposal. Have a good insight into the knowledge and method of the research project.</li> <li>• Under the guidance of a responsible and approachable supervisor, I am quite well prepared so far.</li> <li>• I always feel that much information regarding my research project has not been fully understood.</li> <li>• I do not think that I am fully prepared to handle everything on my own right now.</li> </ul>	<ul style="list-style-type: none"> <li>• Through this research project, I have learnt to be independent as well as gained basic research skills (such as cell culture, aseptic technique, learning how to design a protocol for an experiment through reading articles).</li> <li>• I am more confident in doing the experiment by myself and in analysing data.</li> <li>• There are still a lot of lab instruments that have yet to be learned.</li> <li>• I am not very confident in handling a whole project on my own yet.</li> </ul>
Research ethics	<ul style="list-style-type: none"> <li>• I have learnt that I should report my results based on real and actual data.</li> <li>• I understand the importance of being honest about our results and be responsible for everything that we do.</li> <li>• I only know that the written consent form is important and that I cannot disclose the information of the participants to anyone.</li> </ul>	<ul style="list-style-type: none"> <li>• I have learnt a lot about professionalism.</li> <li>• I am clear that one of its implications is never to change any result or take any shortcut in order to obtain results.</li> <li>• I have learnt to prioritise research ethics more than having perfect data.</li> </ul>
Writing skill	<ul style="list-style-type: none"> <li>• Unable to describe an idea clearly.</li> <li>• I am poor in explaining and discussing results.</li> <li>• Grammar issue and poor in vocabulary.</li> <li>• To write a simple essay may be easy but writing a scientific article requires much scientific writing skills.</li> </ul>	<ul style="list-style-type: none"> <li>• I have a good flow of word processing with least or no grammatical errors. My sentence structures are straight forward and convey ultimate points to the readers.</li> <li>• Reading journal articles had enhanced my writing skill.</li> <li>• I am fully aware of the content I want to write.</li> <li>• My level of writing skills heightened during past 6 semesters</li> </ul>
Presentation skill	<ul style="list-style-type: none"> <li>• Lack of confidence.</li> <li>• Find difficulty in conveying messages during presentation especially when answering questions.</li> <li>• I cannot speak English fluently.</li> <li>• Having stage frights.</li> </ul>	<ul style="list-style-type: none"> <li>• I am able to convey my message clearly, influence and attract the attention of the audience.</li> <li>• I have learnt how to speak more confidently in front of the public.</li> <li>• I can present well because I do not have stage fright.</li> <li>• I can present my ideas fluently, but I would need improvement on the question and answer session.</li> </ul>

Table 1. Students' perceptions of their preparedness to undertake research

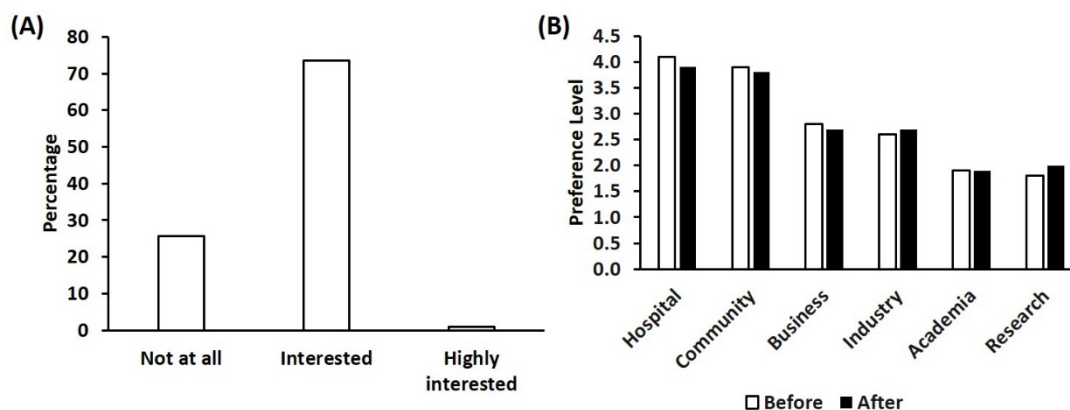
#### F. Impact of Research on Future Career Options

Approximately 73.5% have indicated their interest in research while only 0.9% were highly interested and might have selected research or academia as their future career direction (Figure 2A). 25.6% indicated that they were not at all interested in research. Students were asked to rate their career preference before and after the research project; the result showed that research experience has no significant impact on career selection (Figure 2B). Majority of the students preferred to work in hospital and community setting, followed by business and industry setting, while academia and research are the least popular option.

#### G. Students' Perceptions About the Impact of Research Experience on Their Employment Potential

As shown in Table 2 and in the Appendix B, the students' perceptions were basically supported by skills that

enhance their work-readiness. Other factors included largely personal development and project management skills. Some students stated that exposure to certain industry-related equipment and successful publication of research outputs would enhance their employment potential. On the other hand, students who were not agreeable to this perception stated that their research experience would not enhance their employment potential because their areas of research were not related to either community, industry or hospital pharmacy which they would be involved in the future and they were not keen to venture into research or academia. There were also students who thought that similar curriculum and research experience were available for most pharmacy graduates, hence there will be no difference among the graduates.



Note: Students were asked to rate their preferences in Likert scale ranging from level 1 (least preferred) to level 6 (most preferred).  
 Figure 2. (A) Students' level of interest in research; (B) Students' career preferences before and after the research project

Students' Perception of Whether Research Experience Could Enhance Their Employment Potential	Students' Comments
Yes	<ul style="list-style-type: none"> <li>Besides the knowledge part, research develops my maturity in handling problems, planning in advance, dealing with people and juggle between work and life.</li> <li>While doing the project, I got to enhance my skills in communicating, analysing problems or results, problem-solving and time management. These are all extra skills which could be my strengths to increase employment potential.</li> <li>Research can indeed enhance employment potential as it will help to grade a person's attitude. Persons with lots of research experiences would definitely have more potential to be a good organiser and leader which is essential during employment.</li> <li>Because I gained knowledge and experiences in the field of research, have higher amount of exposures as compared to those who didn't.</li> <li>Research experience sharpened my problem-solving skill and trained me as a self-starter and to work more independently.</li> <li>Research provided opportunities to improve communication and management skills required for employability.</li> <li>Because we know the ways to use certain equipment that is used in the industry.</li> <li>If my research has the chance to be published, it will really strengthen my CV.</li> <li>Open to a new career option.</li> </ul>
No	<ul style="list-style-type: none"> <li>I feel that the research field has no strong correlation with employability.</li> <li>My research project is not directly related to my potential job unless I choose to go into the research field in the future.</li> <li>Pharmaceutical company employers prioritise work experience over whether a candidate carried out a research project or not.</li> <li>Because I am not interested in research.</li> <li>Many other students may have exposure to research in their curriculum, no difference among students.</li> </ul>

Table 2. Students' perceptions about the impact of research experience on their employment potential

### H. Students' Perceptions of Their Research Achievements and Challenges

From the students' perspective, the overall impact of the research projects that they appreciated was the acquisition of new practical knowledge in the rigours of

research which could not be gained from lectures (Table 3). On the other hand, there were several issues and challenges faced by students during the project implementation. Students struggled on issues arising from interpersonal relations which include peers,

supervisors and laboratory support staff as well as time constraint. Other challenges include limited study subjects and specialised equipment, poor time planning, poor knowledge in statistics and research techniques, unpredictable data and experimental failures, limited

research fund and facilities. They also had difficulties with supervisors who were not helpful and who were too busy with other duties as well as delay in the arrival of research consumables.

Aspects	Students' Comments
Achievement of research objectives	<ul style="list-style-type: none"> <li>I was able to answer the questions based on the results collected.</li> <li>The results showed positive results even though further studies might be needed.</li> <li>I was able to achieve my objectives and answer my research question.</li> </ul>
Enhancement of knowledge in subject matter	<ul style="list-style-type: none"> <li>My research project has broadened my knowledge.</li> <li>Definitely, because there were a lot of readings from the literature reviews to understand the theory.</li> <li>I have more knowledge in the polymer chemistry field.</li> <li>I have read a lot on Alzheimer's disease which was related to my research and gained knowledge that I did not obtain from classes.</li> <li>My understanding of drug dissolution and drug carrier was at a superficial level before starting this research.</li> </ul>
Skills gained	<ul style="list-style-type: none"> <li>It definitely did. Successful research requires a deep understanding of the subject.</li> <li>Apart from strengthening my teamwork skills, I have also gained technical skills such as pipetting as well as practising aseptic techniques.</li> <li>I have learnt how to evaluate scientific papers to support evidence-based practice.</li> <li>Self-learning skills, because I have to do all the things by myself</li> <li>Time management skills, because I have to complete everything within the given period</li> <li>I have learnt problem-solving skills that can be applied during research.</li> <li>I have learnt how to conduct survey-based researches and how to use software to analyse data.</li> <li>Communication skill - because it involves almost in discussions and presentation regarding research.</li> </ul>
Challenges faced	<ul style="list-style-type: none"> <li>Difficulty in method optimisation.</li> <li>Struggles with cell cultures at the initial stage of research.</li> <li>Difficulties with working in a team/ partner.</li> <li>Many unexpected scenarios arise during the process. Faced with difficulties in understanding the methodology of the project, particularly data analysis.</li> <li>Time is the biggest challenge we faced throughout the research.</li> </ul>

Table 3. Students' perceptions of the different aspects related to their research achievements and challenges

#### IV. DISCUSSION

This study confirmed that preparation for the research semester enhanced knowledge in topics of interest, research and collaborative skills for students. Through the research program, they are able to appreciate, explain, apply and relate the knowledge gained from research to lessons learnt in lectures. This exposure has enhanced their confidence in pursuing the research topics of interest after graduation. It would also improve their capability to work independently. This agrees with studies that confirmed that hands-on research experiences have been recognised to provide the best learning tools that enhance students' learning, especially when done in collaboration with peers (Ash Merkel, 2003). The research program experience also had a positive impact on ethics and professionalism. Different instructional methods have been shown to be important for the comprehension of ethical knowledge, particularly those that involve intensive students' participation and role-play (Guérin & Bussièrès, 2017). The research program described in this study provides the opportunity for application and comprehension as it requires full

student participation for one semester and with preparation in the prior semester. The importance of engaging students in ethics and professionalism issues has been shown in a few studies related to pharmacy. In a study that compared the understanding of pharmaceutical ethical statements between pharmacy students and hospital pharmacists, a significant difference in understanding was reported in areas that were assessed, particularly in clinical research, advertising and marketing, dispensing medication, pharmaceutical care and code of ethics. The probable reason for this is knowledge in professional ethics obtained during undergraduate training might not be readily translated to actual professional practice (Guérin & Bussièrès, 2017). The importance of the right training in instilling ethical knowledge was again emphasised in another study in which the effectiveness of an early professional development series in a pharmaceutical care laboratory (PCL) course for first-year pharmacy students that highlighted the application of the Oath of a Pharmacist and the Pharmacists' Code of Ethics. The results showed that while students entered their training

with a strong appreciation for professionalism, they felt more confident in applying the Oath of a Pharmacist and the Pharmacists Code of Ethics to dilemmas in practice following each new learning activity that required active participation and application (Smith & Dinkins, 2015).

It was also noted that the research program could enhance skills related to scientific communication. Good writing and presenting skills are not naturally acquired skills but must be developed through multiple practice experience. Prior to the research program, these students have undergone several tasks that provided training to improve writing or presentation skills, namely assignments, practical reports, case reports, seminars and examinations in form of essays which were associated with the respective course. In addition, self-confidence was reported to be correlated with the writing ability or performance (Pajares & Johnson, 1994; Ranelli & Nelson, 1998). Another contributing factor to scientific communication is proficiency in the language of communication. Writing might pose a challenge to students who have poor language proficiency especially when it is a second language to students (Chokwe, 2013). In the context of this study, it is English language proficiency as the undergraduate pharmacy program is delivered in English while all students in this program are not native English speakers, but use English as a second language.

Participation in oral presentations was shown to enhance students' critical-thinking and problem-solving skills especially when followed with a question and answer session. In addition to enhancing student learning experience and reflection, it provides an opportunity for students to evaluate their own as well as their fellow classmates' presentations and develop their skills in providing constructive feedback (Hunter, Laursen, & Seymour, 2007). Moreover, the need for troubleshooting, critical analysis of the results and problem-solving during the course of the project contributed to the development of these skills. The benefits of faculty-mentored research projects have been well-recognised and shown to facilitate active learning, cultivate self-confidence as well as enhance students' critical-thinking and communication skills (Bauer & Bennett, 2003; Lopatto & Tobias, 2010). Translating classroom teaching and reading into hands-on learning activities has been reported to promote personal skills development and enhance the learning experience (Chopin, 2002). The research programme has provided students with an insight into research and development, hence opening a new career option. It was noted that students with research experience were more prepared to pursue careers in science (Lopatto, 2007). Importantly, our findings suggest the skills and competencies gained from

the research projects are aligned to the expanding roles of pharmacists that require evidence-based practices as reviewed by Bond (2006) and van Mil and Fernandez-Llimos (2013).

Several important practical points pertaining to the implementation of undergraduate pharmacy research projects are worthy of considerations. Perhaps the most important being the importance of a 16-week immersive experience in the rigours of research. In the current study, the number of laboratory projects exceeded the projects related to pharmacy practice and pharmacy education. A possible solution to this would be to encourage staff who are practising pharmacists to develop research ideas with their counterparts from other areas of expertise such that there are diversity and relevance of these research projects for future practice. Moreover, only perceived students' competencies are addressed in this study and follow-up studies with objective measurement of competencies will be carried out.

## V. CONCLUSION

Overall, the Pharmacy students surveyed in this study indicated that the impact of a research program has offered them an immersive experience to develop various skills and increased their perceived competencies, knowledge as well as confidence in carrying out research work in diverse disciplines. For academics implementing research programs for undergraduate pharmacists, this study also shows some of the challenges students faced.

### Notes on Contributors

Eng Lai Tan (E.L.T.), PhD., is an Associate Professor in the Department of Life Sciences, School of Pharmacy, International Medical University (IMU). He is also the associated Dean of School of Postgraduate Studies, IMU.

Sook Yee Gan (S.Y.G), PhD., is an Associate Professor in the Department of Life Sciences, School of Pharmacy, IMU.

Wei Meng Lim (W.M.L.), PhD., is a lecturer in the Department of Pharmaceutical Technology, School of Pharmacy, IMU.

Vishna D. Nadarajah (V.D.N.), PhD., is the Pro-vice Chancellor of Education.

Peter C.K. Pook (P.C.K.P.), PhD., is the Deputy Vice Chancellor of IMU.



E.L.T., S.Y.G., V.D.N. and P.C.K.P. were involved in the design of the work. E.L.T. and S.Y.G. have administered data collection through surveys. E.L.T, S.Y.G. and W.M.L. conducted data analysis and interpretation. E.L.T and S.Y.G. drafted the article. V.D.N. and P.C.K.P. initiated the study and revised it critically. All authors approved the final version for publication in TAPS.

### Ethical Approval

This study was exempted by Institutional Review Board (IRB). This study is part of the regular programme audit conducted by the School of Pharmacy, the findings of which had been reported to the school's curriculum and examination committee for quality assurance purpose.

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### Declaration of Interest

The authors report no declaration of interest.

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\*Eng Lai Tan  
 School of Pharmacy,  
 International Medical University  
 126, Jalan Jalil Perkasa 19,  
 Bukit Jalil, 57000  
 Kuala Lumpur, Malaysia  
 Tel: +603-2731 7466  
 Email: englai\_tan@imu.edu.my

Appendix A: Pre-study Questionnaire

Pre-U background :

Research Project type : Non-lab based / Lab based

Location of Research :

Main supervisor :

Research Area: Pharmacy Practice / Pharmaceutical Technology / Pharmaceutical Chemistry / Life Science / Medicine / Dental / Other Health Sciences

1. Rank the following six areas that you are likely to venture in the future (Rank 1: Most likely, Rank 6; Least likely).

Community : \_\_\_ Business : \_\_\_ Industry : \_\_\_ Hospital : \_\_\_ Academia : \_\_\_ Research : \_\_\_

2. What is your preference for your current project? 1st choice / 2nd choice / 3rd choice / Not at all

3. Which of the following factors determine(s) your choice for your research project? You may choose more than one answer Supervisor / Peer choice / Research interest / No other option / Not sure

4. Do you think the research module will be useful to enhance your critical thinking skill? Yes/No

Explain: \_\_\_\_\_

5. Do you think that research experience will enhance your employment potential? Yes/No Explain:

For the following questions, please rate according to the scale of 1 to 4 (1-Poor; 2-Satisfactory; 3-Good; 4-Excellence) and explain your choice.

6. How do you rate your writing skill? 1 2 3 4

Explain:

7. How do you rate your current preparedness to undertake research project? 1 2 3 4

Explain:

8. How do you rate your presentation skill? 1 2 3 4 Explain:

9. How would you rate your knowledge in research ethics? 1 2 3 4 Explain:

10. What aspect(s) of research ethics is/are applicable to your future as a pharmacist?

## Appendix B: Post-Study Questionnaire

Evaluation of outcomes of BPharm research projects at end of semester 7

1. Which area you think you will venture in the future?

Community/business / Industry / Hospital / Academic / Research / Post graduate

2. Do you think that research experience will enhance your employment potential? Yes/ No Explain: \_\_\_\_\_

3. How do you rate your writing skills? Poor/ Satisfactory/ Good/ Excellence Explain: \_\_\_\_\_

4. How do you rate your current preparedness to undertake research project? Poor/ Satisfactory/ Good/ Excellence Explain:  
\_\_\_\_\_

5. How do you rate your presentation skills? Poor/ Satisfactory/ Good/ Excellence Explain: \_\_\_\_\_

6. How would you rate your knowledge in research ethics? Poor/ Satisfactory/ Good/ Excellence Explain:  
\_\_\_\_\_

7. What is your interest level in research?

- Not at all (I will never consider doing research)
- Interested (I will consider doing research when there are opportunities)
- Highly interested (I will definitely do research)

8. Has Semester 7 research modules enhanced your critical thinking skills? Yes/ No Explain: \_\_\_\_\_

9. Were you able to answer your research question in your project?

Yes / No / Not sure Explain: \_\_\_\_\_

10. Did your research project enhance your knowledge in the subject matter? Yes/No/ Not sure

Explain: \_\_\_\_\_

11. Briefly describe skill(s) that you have gained from the research experience.

12. Briefly describe challenge(s) that you have faced in your Semester 7 research project.