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ORIGINAL RESEARCH

Development and Evaluation of a Mandatory Research Experience in a Medical Education Program: The Independent Learning Project at UNSW

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Abstract
As part of the reform of its undergraduate 6-year medical program, the University of New South Wales developed an in-depth research experience of 24 weeks full-time duration, which all students are required to undertake. Central aims of this Independent Learning Project (ILP) are to develop the generic capability of self-directed learning and critical evaluation, to understand how knowledge is created within a field and its limitations, and to reinforce the scientific basis of medical practice through personal research experience. The ILP is taken in either year 3 or 4 in any area of research relevant to medicine, including biomedical science, public health, and clinical research. Assessment includes supervisor grades and a report in the form of a scientific manuscript. High achieving and motivated students have the option of substituting the ILP period with a formal Bachelor of Science (Medicine) Honours degree, which is 28 weeks in duration with a more rigorous assessment. Currently, this Honours option is limited to the academically best (~30) students each year. Between 2006 and 2010, 846 students completed an ILP and 159 undertook an Honours project in lieu. At least 64 peer-reviewed manuscripts have been published as a result of ILP projects. Student evaluations are generally positive with 65% of respondents undertaking an ILP in 2009-2010 reporting that they were satisfied with their experience. Motivation, interest, and recognition were the key factors which characterized students who reported satisfaction with their ILP experiences. In open-ended comments, students reported key intellectual outcomes related to research as the highest ranked 'best aspects' of their ILP. The most frequent negative comments reflected resistance to the compulsory nature of the ILP, a need for better selection or training of supervisors, and interruption to their clinical learning.

Introduction
There have been numerous benefits proposed for intercalating an in-depth period of biomedical research into medical training degrees.[1-4] Some medical educators propose that giving such an opportunity to a select group of medical students, with an interest in research, will facilitate their development into clinician-researchers. Examples include the combined MD-PhD programs offered by various North American universities. One stated reason for the introduction of these programs was to stop the perceived decline in numbers of clinician-researchers, who were often referred to as a "dying breed".[5-9] An alternative view is that *all* medical students would benefit from such a period of intense research, not in the hope that it would turn them into clinician-researchers, but because it would better prepare them for the challenges faced by practitioners in the age of scientific evidence-based medicine.

Consistent with the latter philosophy, The University of New South Wales (UNSW) introduced a new six-year medical curriculum in 2004.[10] What distinguished the new curriculum was a requirement for all medical students to undertake a significant period of in-depth biomedical research in a field of their choice. This initiative was called the Independent Learning Project (ILP). Although there are multiple reasons why such a program may

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benefit medical students, three were believed to be of overriding importance.

Firstly, students would become aware of how knowledge is created in their chosen area. In turn the students would gain insight into the development, accumulation, and limitations of the broader range of medical knowledge that they are exposed to during their medical education. Secondly, students would develop a comprehensive knowledge of the current resources available in their chosen field, which would enable them to frame researchable questions, and undertake appropriate research to answer those questions. Thirdly, the students would develop lifelong self-directed learning patterns and skills. The next wave of medical graduates will be required to have highly developed learning behaviors to enable them to remain in contact with the rapidly changing face of modern medicine. The rigor and depth required for such a task is not possible without a detailed knowledge of the formal processes of research, literature appraisal, data collection, analysis, and presentation.

Whatever value medical educators see in such a program, it was not clear what level of acceptance would be observed in medical students, many of whom are impatient to study "clinical medicine". In this report, we present a description of the ILP and the results of an evaluation of the program from the students' perspective.

The UNSW Independent Learning Project

The new medicine program at UNSW is six years in duration, split into three phases, each of approximately two years duration.[10] All courses are interdisciplinary and the biomedical/social sciences and clinical aspects are integrated throughout all years of the program. Phase 1 of the program has a greater focus on the sciences underlying medical practice, Phase 2 has equal emphasis, while Phase 3 has a greater clinical focus.

The ILP is undertaken by medical students during Phase 2, either in year 3 or year 4 of the program. Students undertake a period of supervised biomedical, public health, or clinical research for the equivalent of 24 weeks of full-time study scheduled over 32 weeks. There are two methods by which students can find a suitable project; 1) by negotiation and development of a project in collaboration with an academic supervisor, or 2) by being allocated to a project that has already been developed by a supervisor. In the first iteration in 2006, only one third of students negotiated a project but this percentage has now increased to ~85% (Table 1).

Independent Learning Project (ILP)				BSc(Med) Honours
Cohort	Allocated	Negotiated	Total	
2006-2007	85 (66%)	44 (34%)	129*	53
2007-2008	99 (58%)	71 (42%)	170	33
2008-2009	43 (22%)	149 (78%)	192	17
2009-2010	42 (20%)	173 (80%)	215	23
2010	21 (15%)	119 (85%)	140*	33#

Table 1: *Student numbers (percentages) undertaking ILPs and BSc(Med)Honours. * Approximately one half of full cohort, # Full cohort.*

Aims, Assessments and Supporting Coursework Sessions

During the ILP students are expected to achieve the following specific goals:

- develop an ability and inclination to question the basis of current scientific thinking in relation to medical practice.
- retrieve literature on a topic and demonstrate a familiarity with the use of medical databases.
- evaluate current knowledge in a field and to provide a critical appraisal of that body of knowledge.
- identify a problem in their chosen field and to understand and implement the process of designing a scientific investigation of the problem.
- be aware of the ethical issues involved in medical research and be able to write an ethics proposal for their proposed study.
- evaluate data critically including the appropriate use and interpretation of statistics.
- communicate findings and interpretations in their chosen field, both orally and in writing with experts, peers, the media, and general public.

To support students during their research experience, a series of introductory lectures/ workshops and a series of mid-year coursework modules are offered (Table 2). ILP students generate two assessable outputs. At the end of the first eight-week period, students submit a 3000 word literature review, assessed as satisfactory/ unsatisfactory by the supervisor, and at the end of the ILP period, they submit a written final report in the form of a 5000 word research paper. The student's overall mark for the ILP is derived from a

grade awarded by the supervisor based on the student's overall performance during the year including the literature review (40%), and a grade awarded by the external examiner for the final ILP report (60%). A student has to gain a combined score of at least 50% in order to successfully complete the ILP.

Introductory Modules	Evaluation*	Mid-Year Modules
1. Learning to think scientifically.	62%	1. Advanced quantitative research methods,
2. Occupational health and safety in biomedical research	-	2. Advanced qualitative research methods
3. Strategies for retrieving literature	-	3. The art of scientific writing
4. Introduction to bibliographic software	-	4. Writing a scientific paper
5. How to write a literature review	79%	
6. Project and Time Management	67%	
7. Student –Supervisor Relationship: The supervisor's perspective!	-	
8. Introductory quantitative research methods	65%	
9. Introductory qualitative research methods	47%	
10. Ethics	45%	
11. Research in a clinical environment	65%	

Table 2: *Coursework modules offered to all ILP students and student evaluations. * Percent of student responding strongly agree or agree to 'I learnt a great deal from this session'.*

Evaluation of UNSW's ILP

Methodology

A 21-item questionnaire was developed, piloted with a previous group of students, and administered to the 2009-2010 cohort group to evaluate their ILP experience (UNSW Human Research Ethics Advisory Panel approval number #2009-7-58). Participants had recently completed their ILP, were unaware of their assessment grades, and were contacted by email inviting completion of an online evaluation. The questionnaire (Appendix 1) contained 17 items that asked students to respond to statements exploring their interest in, and value of, the project, their supervisor, available support, and workload using a five-point Likert scale (only rarely, sometimes, about half the time, frequently, and almost always). Item 18 asked students to rate their overall level of satisfaction with the ILP experience on a four-point Likert scale (very satisfied, satisfied, dissatisfied, very dissatisfied). Two open-ended items asked for comments on the 'best features of the ILP' and areas of the ILP that 'could be improved'. Item 21 asked students to rate the value of seven specific educational sessions within the ILP using a four point Likert scale (strongly agree, agree, disagree, strongly disagree).

The data were analyzed using Predictive Analytics Software (PASW - version 18). Fourteen of 17 items of the questionnaire were assigned to three subscales (motivation, supervisor, and support), each containing four to five items with a Cronbach's alpha of 0.89, 0.92, and 0.86 respectively. Responses to the overall satisfaction item were combined into two groups; satisfied (very satisfied and satisfied) and dissatisfied (very dissatisfied and dissatisfied). Independent t-tests were used to investigate differences between satisfied and dissatisfied students on each of the subscales. Stepwise regression was used to investigate the amount of variance accounted for by each of the subscales for overall satisfaction. The open-ended items containing qualitative comments were analyzed using *CEQuery* (version 1.13), which searches and categorizes comments into five broad educational domains and 31 sub-domains.[11] In addition, qualitative comments were probed using the search term 'supervisor'. Students and supervisors for all cohorts who have undertaken an ILP since 2006 were requested to report any publication arising from ILP research. The numbers of students completing an ILP and BSc (Med) Honours degree were obtained from university records.

Evaluation Results

Of 215 medical students undertaking an ILP in 2009-2010, 202 were contacted and 118 completed the questionnaire, a response rate of 59%. Demographics of the 118 respondents showed no significant differences compared to the larger cohort, indicating that responses were likely to be representative. Table 3 shows that 65% of students were satisfied with their ILP experience. Students who negotiated their ILP project had a greater level of satisfaction than those individuals who had an ILP project allocated to them (mean response 2.13 versus 2.50, p=0.045), but responses to all other

items were not statistically different between these two groups.

Response	All Students (n=118)	Negotiated Projects (n=82)	Allocated Projects (n=36)
Very Satisfied*	21	24	14
Satisfied*	44	44	45
Dissatisfied*	24	26	19
Very Dissatisfied*	11	6	22
Mean Response†	2.25	2.13	2.50

Table 3: *Student responses to the question 'How do you rate your level of satisfaction with the ILP experience in Medicine to date?*
** Data shown are percentage of student responses in each category*
† Data shown are mean values in each group where 1 = very satisfied, 2 = satisfied, 3 = dissatisfied and 4 = very dissatisfied.

To explore reasons why students had positive or negative ILP experiences, responses between satisfied (n=77) or dissatisfied (n=41) students were compared, revealing significantly more positive ratings for all 17 items by satisfied students. When the mean responses for items in each subscale were compared, the greatest differences between satisfied and dissatisfied students were in the 'motivation' subscale, followed by the 'supervisor', then 'support' subscales (Figure 1). A stepwise regression analysis showed that the 'motivation' subscale accounted for 68.1% of the variance between satisfied and dissatisfied student responses (beta = 0.825, $p<0.0005$) with the supervisor subscale, support subscale, and the remaining 3 items were not significant predictors in the model.

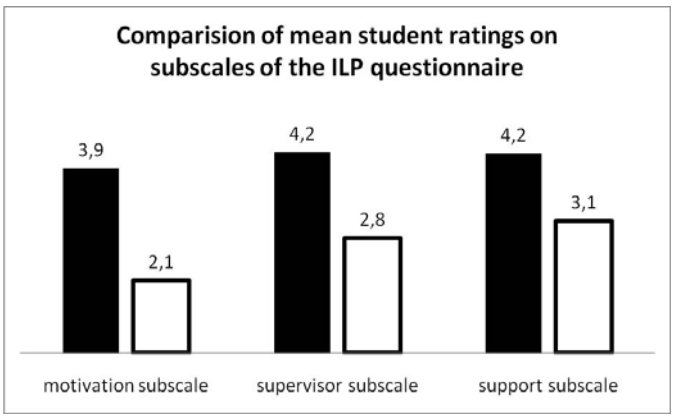

Figure 1: *Mean ratings on items within motivation, supervisor or support subscales by students who were satisfied (solid bars) or dissatisfied (open bars) with their ILP experience.*

Evaluation of specific educational sessions offered to all ILP students showed positive ratings were noted for the 'quantitative research methods', 'thinking scientifically', 'literature review writing', and 'time management' topics, with lower positivity for the sessions on 'ethics' and 'qualitative research methods' (Table 2).

Best Aspects		
Rank	Sub-domain	Hits
1	Outcomes_intellectual	29
2	Course_design, methods	19
3	Outcomes_knowledge, skills	12
4	Course_design, flexibility	8
5	Staff_quality	8
Could be Improved		
Rank	Sub-domain	Hits
1	Course_design, methods	18
2	Course_design, flexibility	10
3	Course_design, structure	9
4	Staff_quality	8
5	Staff_accessibility	8

Table 4: *Top ranked open-ended comments in 'Best Aspects' and 'Could be Improved'.*

The 118 respondents provided a total of 175 comments in the two open-ended items; 84 comments in the 'best aspects' item, and 91 in the 'could be improved' item. A *CEQuery* analysis of these comments resulted in 217 'hits', equally split between 'best aspects' and 'could be improved' items (110 and 107 respectively). Table 4 shows the five top ranked sub-domains for each item in which student comments were categorized. Of note, students reported intellectual and knowledge and skills outcomes as the first and third most frequent 'best aspects' of their ILP experiences. Examples of typical comments relevant to these sub-domains are as follows:

> *"The opportunity to enter a productive and busy research environment was invaluable in terms of learning new skills and understanding the kind of commitment and effort that one needs to put into research … My experience of the ILP has given me an appreciation for the merit of including a research component in an undergraduate medicine program because I now have an insight both into the way in which research influences clinical practice and also the mechanics of it on a very practical level … The opportunity to learn outside of the project itself; to experience the research community; to take part in something that many would not choose to do by choice; the flexibility; studying in a very different way … It gives students a stronger understanding of the value of*

research and how to assess our sources … Getting to know the team, I was more comfortable with them and learned a lot beyond my focused research. Having done significant data analysis myself as well, I understood the difficulties and the use of different tests."

On the other hand, the most frequent comments in the 'could be improved' item related to the course design domain. A common theme was resistance to the mandatory nature of the ILP courses.

"I think it is ridiculous to expect every student to complete a lengthy research project like writing a thesis, it requires a lot of dedication and self-motivation, and thus if it is compulsory many students who are not particularly interested in research will spend a year being bored, lazy, and unproductive … More support for negotiated projects in choosing a topic, perhaps more time allowed until after literature review is finished … Better teaching of statistical methods and analysis, a more rigorous explanation of how to set out and organise the project … My lab based project required more hours than I could cope with at some points … Providing more information session on how the project should be going."

Since the quantitative items indicated that issues relevant to the students' supervisor were the second most important factor differentiating satisfied versus dissatisfied students, we search the open-ended comments using 'supervisor' as a search word. The following comments are typical of the open-ended responses found in the 'best aspects' item"

"I think it's crucial to have a supportive supervisor, as I had … Supervisors gave me the opportunity to gain experience in writing a manuscript, submitting a manuscript for publication and poster presentation in a research meeting … Some supervisors are wonderful to work with, as are some work environments … Getting an introduction into a research environment, and the support provided by my supervisor and his colleagues in assisting me through this process."

Other students commented about their supervisors in the 'could be improved' item:

"Supervisors need to have more time to teach, guide, and explain things to us … Greater education of supervisors as to the expected aims and student involvement … Better communication between the faculty and supervisor, emphasis on the number of hours per week … Perhaps if the university could stress the need for supervisors to check on students and their progress regularly … I felt lost for most of the year and proper supervision was lacking … Supervisors that were more attentive to the students need and meet up more often with the student."

Research outputs

For the period 2006-2010, in which 846 students have undertaken an ILP, 64 peer-reviewed manuscripts have been published in which an ILP student has been an author. The average number of medical students opting to complete an intercalated BSc(Med)Hons from 2006-2010 has been ~32 per year, whereas for the period 2000-2005 it was less than four students per year.

Discussion

There are a number of potential and proven benefits of undertaking a substantial research experience within an undergraduate medical degree program. These advantages include development of generic or transferable skills, positive effects on learning approaches, better grades in subsequent medical school exams, a greater interest in research, and possible encouragement of the students to pursue future academic medical careers[2-4]. In most medical schools, undertaking a research experience is optional, often for academically gifted and/or highly motivated students, constituting an intercalated research degree, whereas in other schools, it is a mandatory component of the medical program for all students.[1-4] At UNSW, we chose the latter option, in part because of a strong commitment to develop generic capabilities such as self-direction and critical evaluation in all UNSW medical graduates.[10,12]

We reasoned that an extended period of in-depth learning within one field of medicine and/or its underlying sciences was an ideal opportunity in which students could be engaged in a number of activities that would enhance self-directed learning capabilities. These competences include searching and accessing literature sources, critically appraising relevant literature (including recognizing limits and deficits in studies), synthesizing a student's own understanding of the topic of study in a written literature review and an oral presentation, and articulating hypotheses to be tested in experimental research. Furthermore, through the process of undertaking an original research project, we hoped students would better recognize the scientific process of how knowledge is created and

continuously updated, and understand the dynamic nature of 'current understanding'. Our aim was not so much to generate a number of academic clinician-scientists within our student cohort, though this result may well be a consequence, but to improve the clinical practice of all our graduates through fostering development of key lifelong learning capabilities which we believe are vital for 21st century medical practice.[13]

The evaluation of the compulsory research experience at UNSW described in this paper indicates a provisional success with areas for improvement. Students are generally positive with 65% of ILP students reporting they were satisfied with their experience. The academically top ~30 students in the program who 'upgraded' their ILP to a formal Honours project were not evaluated in this study, but one would expect them to have greater levels of satisfaction, suggesting that overall satisfaction rates for the larger cohort with their research experience is closer to 70%. The increased interest by our medical students in undertaking a formal BSc(Med)Honours degree in lieu of an ILP is, in itself, a strong argument that many students recognize the value of research experiences. Our students noted key intellectual outcomes as the best aspect of their ILP (Table 4), which provides support for our aim to use this experience to develop higher order generic capabilities, and is in agreement with previous literature[4]. A recent survey of United Kingdom (UK) medical students showed that between 57% and 77% of respondents recognized the value of a research experience in developing new skills and broadening their knowledge.[14]

Nevertheless, a significant minority of our students was dissatisfied with their ILP experience, and this outcome was more likely if the project was allocated to the student, compared with cases where students were involved in negotiating the project and/or choosing their supervisor (Table 3). In open-ended comments, a common negative was the compulsory nature of the ILP experience, and perceived lack of interest in research and/or seeing research as irrelevant to clinical practice. UK medical students who declined an optional research year most commonly cited additional time and financial burdens as reasons for their decision.[14]

In trying to understand factors associated with positive rather than negative ILP experiences, we divided items within our questionnaire into 3 subscales (Appendix 1). The dominant factor that distinguished satisfied versus dissatisfied students was the 'Motivation' subscale which included items relating to interest, feeling valued, and development of educational outcomes (Figure 1). Indeed the 5 items in this subscale accounted for 68% of the variance between the two groups, and other items were not significantly different in a step-wise regression model, once the Motivation subscale was considered. This result suggests that encouraging student engagement with the ILP, including participation in negotiating a project topic and/or a research supervisor or team, is a key factor in making the ILP as positive an experience as possible. Improving the selection, training, and support for ILP supervisors is likely to be an additional area that will enhance the experience and educational outcomes for ILP students.

Conclusions

In conclusion, we report a high level of student satisfaction and provisional evidence of successful achievement of important learning outcomes during a 24-week research experience undertaken by all medical students at UNSW. The mandatory nature of the ILP has encouraged a strong demand for completion of an intercalated Honours degree by highly motivated students, and resulted in significant research publications. Encouraging student engagement with the ILP experience and supporting good supervision are key factors in ensuring a research period is a valuable learning experience.

Notes on Contributors

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Keywords

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Appendix

Item	Statement	Subscale
Items 1-17 response (only rarely, sometimes, about half the time, frequently, almost always)		
1	I have received sufficient preparation for my ILP.	-
2	It was easy to identify an interesting project	Motivation
3	I had a clear idea of what was expected of me	-
4	The workload for my ILP has been reasonable	-
5	Sufficient help and advice has been provided whenever I have needed it	Support
6	I have access to adequate resources/equipment for my project	Support
7	I have received adequate help with using equipment required for my project	Support
8	My supervisor provides constructive feedback that helps me learn and develop my skills.	Supervisor
9	Other people in my ILP location understand and support my role as a student.	Support
10	I am made to feel comfortable about asking questions	Support
11	My supervisor and I have discussed my learning and development needs for my project.	Supervisor
12	My supervisor is receptive to my point of view on matters that affect my project.	Supervisor
13	My supervisor regularly discusses clear and specific performance objectives for me.	Supervisor
14	I have been able to develop skills related to my interests and concerns.	Motivation
15	My project is valuable to the team/organization I am located in.	Motivation
16	My efforts and achievements are recognised	Motivation
17	I have found my ILP project interesting and stimulating.	Motivation
18	How do you rate your level of satisfaction with the ILP experience in Medicine to date? – Response (very satisfied, satisfied, dissatisfied, very dissatisfied)	
19	The best features of the ILP experience for students are:	
20	The ILP experience could be improved for students by:	
21	Please rate the ILP sessions that you were involved in from strongly agree to strongly disagree in response to the statement "I learnt a great deal from this session". – Response (strongly agree, agree, disagree, strongly disagree) a) Ethics b) Learning to think scientifically. c) Introduction to quantitative methods d) Introduction to qualitative methods e) Research in a clinical environment f) How to write a literature review g) Time and project management	

Appendix 1: *Student Evaluation of the Independent Learning Project (ILP) Experience Questionnaire*