Medical Students’ Learning Experiences And Perceptions Of Immunology

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Abstract
Background
A major hurdle for medical educators today is determining how to effectively engage students in their study of immunology so that the concepts learnt can be retained and applied in the clinical years and beyond. No study has yet examined this in a systematic manner.

Aims
This study aims to investigate medical students’ learning experience of basic immunology and their perceptions of the relevance of immunology to their current education and future professional lives.

Method
A total of 131 medical students from Years 1-5 at the University of Tasmania, Australia responded to an online, self-administered and anonymous survey. Both quantitative and free-response qualitative data were subjected to statistical analyses to explore the students’ perceptions and learning experiences in their study of immunology.

Results
The students felt learning immunology is important and justified in their medical education; but they did not enjoy the learning experience. The students found immunology to be complex and difficult to relate to clinically. They also indicated that they are less likely to apply learnt immunological principles/concepts in their future practice of medicine.

Conclusion
Immunology is a challenging subject that may be overwhelming for medical students. Innovative teaching approaches need to be employed by medical educators to emphasise the pertinence of immunology in medical education and to engage students in experiential learning. Recommendations on improving students’ educational experiences in immunology and areas of future research were also proffered.

INTRODUCTION
Immunology is a fundamental discipline of medicine that examines the molecular and cellular mechanisms of how the body defends itself against foreign entities, as well as its involvement in the pathogenesis of many physical and mental diseases. The subject area emerged in the late eighteenth century when the English scientist, Edward Jenner, successfully created the first smallpox vaccine.1 This momentous work had a profound effect on medicine, marking one of the first applications of preventative medicine and the genesis of modern-day immunology.2 Shortly after World War II, the paradigm of immunology and immunology research flourished, transcending from its basic defining principles to create a plethora of sub-disciplines, such as immunopathology and immunogenetics, that characterise the area of immunology today.1 To date, immunology has formed an important part of medical curricula around the globe, providing the foundation for studies on human health and diseases.3 The move towards an integrated problem-based/case-based learning (PBL/CBL) structure poses new challenges towards basic medical science teaching which must be integrated with clinical situations,4 and certainly for immunology, there is no exception. Whilst such general challenges have been extensively explored with basic sciences, immunology specifically has so far been neglected in the literature. There is a dearth of information and limited quantitative data on students’ perceptions of immunology as a biomedical science subject. Based on anecdotal5,6 and limited research evidence,7,8 it appears that medical students find immunology difficult to understand and relate to clinically. Bansal7 surveyed final year medical students’ views on immunology teaching. He reported that although 80% of the
respondents agreed that immunology was important in the practice of medicine, only a third of them found preclinical and clinical teaching of immunology interesting. He also reported that three quarters of the respondents indicated that immunology was hard to understand. This finding underscores the report by Piskurich,8 that immunology can be hard for first and second year medical students to understand.

In the five-year undergraduate medical course at the University of Tasmania (UTAS), formal immunology teaching is present only during the first 3 years (pre-clinical years). Fundamental immuno-biology, taught via the CBL system, is concentrated around Year 1 and is delivered by immunologists. The programme consists of basic concepts from immune system components, immune activation through to immune system tolerance and regulation. During Years 2 and 3, the content becomes progressively more clinically-focused on immunopathology, including immunodeficiencies and haematological malignancies and is often delivered by clinicians. Case-based presentations and self-directed learning are frequently employed in the latter pre-clinical years for immunology education. The course then progresses into clinically-relevant material for the clinical years, covering content areas such as vaccinations, allergies and hypersensitivities and cancer medicine. However, basic immunobiology is not reinforced at this point.

Using a cross-sectional study design, this research aimed to address the relative paucity in the literature by investigating the perceptions and educational experience of basic immunology among medical students at UTAS. The main objectives and sub-objectives of the study were:

1. To examine the factors that influence medical students’ perceptions of immunology in their current study and future medical practice by investigating: (a) the effect of the individual factors and (b) the correlation between the factors.
2. To determine the differences in student perceptions of immunology, in relation to their gender, origin and year of study.
3. To explore the students’ learning experiences in order to provide insights that will help medical educators develop student-centred teaching methods which facilitate better engagement, retention and application of learnt concepts.

METHODS

Study Design

Medical students’ educational experiences and perceptions of the study of immunology at the School of Medicine, UTAS were assessed through a cross-sectional online, self-administered and anonymous survey. Data were automatically collected through a secure online repository. This research included both quantitative and qualitative data collection and analysis.

Participants

All medical students across the five years of study (n = 577) were contacted via email. The survey was made available for a period of 3 weeks to all the enrolled medical students in 2011. The survey was administered to participants between weeks 3 and 6 in Semester 2 (second-half of the academic year) to ensure that first-year students have had a solid exposure to immunology before the administration of the survey. Most of the basic immunobiology teaching is concentrated around the first-half of first year.

Procedure

All enrolled medical students were invited to participate in the study. Through the Student Affairs Office, an invitation letter, including a link to the on-line survey and an information sheet detailing the rationale for the study were sent to each student’s UTAS email account. The students were informed that completion of the on-line survey was considered as informed consent. Students were assured of no adverse academic repercussions for non-participation. No incentive was offered for participation; but the benefit of participation was stressed. At the one-week mark, verbal reminders were made to the Year 1, 2 and 3 student groups in classroom settings. This was not possible for the Year 4 and 5 student groups because the students were on separate clinical attachments. At the two-week mark, a second email was sent out via the Students Affairs Office encouraging any last-minute participation. Ethics approval for the study was obtained from the Tasmanian Health and Medical Human Research Ethics Committee at the University of Tasmania.

Survey Instrument

An 18-question online survey was administered, comprising three demographic questions (year of study, gender and student origin) and 15 positively-worded questions assessing students’ learning experiences and perceptions of immunology in their medical education. Ten of the questions employed the 5-point Likert scaling system, where the value 1 = most negative and 5 = most positive, two were multi-select questions and the remaining three were qualitative free-text questions (Appendix 1).

The Likert-scale and demographic questions were used to examine the factors that influence medical students’ perceptions of immunology. The Likert-scale questions were developed based on the work of Bansal, however, they were revised by two immunology tutors for construct validity. In addition to investigating students’ perceptions of
the importance, relevance, justification, usefulness, level of understanding, ease and applicability of immunology to their current study and future medical practice (as measured by Bansal); the revised survey instrument also included three additional factors namely: enjoyment, appreciation, and concepts (Appendix 1). The relationships between the factors (survey variables) and the differences in student perceptions of immunology, in relation to their gender, origin and year of study were also measured. The multi-select and qualitative free-text questions were designed to explore students’ learning experiences in greater depth by investigating their motivation of studying immunology as well as their study techniques and resources. Respondents were also asked to provide further insight into any concerns they may have had during their study of immunology, how such concerns may be best addressed and general comments about the subject.

Data Analysis
Quantitative data: Mean scores for each Likert item and statistical analysis to ascertain levels of significant differences, and possible interactions between the variables were calculated using General Linear Model procedure (PROC GLM) and ordinal regression analysis in the Statistical Analysis Software (SAS, 2009) package. These techniques were used to assess the impact of year of study, gender and student origin (fixed effects) on students’ perceptions of immunology (using the Likert-scale ordinal factors). Similar results were obtained from both models. In this paper, we have reported the analysis based on the linear model because of ease of interpretation of data. This approach has been confirmed in the literature to be valid and reliable. Norman9 in a recent publication stated that “parametric statistics can be used with Likert data, with small sample sizes, with unequal variances and with non-normal distributions, with no fear of coming to the wrong conclusion”. Separation of significant means (p < 0.05) was conducted using Duncan’s multiple range tests. To determine the magnitude of statistically significant relationships, effect sizes were calculated using partial eta-squared (η²p). Relationships between the dependent factors were computed using Spearman’s correlation coefficients and significance was established using Bonferroni probabilities in the correlation analyses (PROC CORR) procedures (SAS, 2009). The overall reliability of the test items was very good with Cronbach’s alpha = 0.85. Internal consistency for each measure of educational experience of immunology was high with Cronbach’s alpha ranging from 0.83 to 0.86.

Qualitative data: Data from the free text responses were analysed using classical content analysis and thematic coding. The qualitative data analysis occurred in two stages: line-by-line coding of key terms and phrases and the organisation of the key terms and phrases into related areas to construct descriptive themes. Microsoft Excel was used to facilitate the sorting, content analysis and thematic coding process. Consensus on emerging themes was reached after they had been independently identified and coded by the authors. Illustrative quotes were reported verbatim to support the discussion.

RESULTS
One hundred and thirty one (131) students participated in this study, comprising 32 Year 1 (27.4%), 27 Year 2 (22.0%), 28 Year 3 (23.3%), 29 Year 4 (24.0%) and 15 Year 5 (15.6%) students. Overall, 63 (48.1%) of the respondents were males and 68 (51.9%) were females; 99 respondents (75.6%) were domestic students, 30 (22.9%) students were international and 2 students (1.5%) identified themselves as being ‘Other’. This group of students may have included New Zealand students and/or permanent resident students. This survey distribution is representative of the domestic/international student profile at UTAS.10,11

Research Question 1: Factors that influence medical students’ perceptions of immunology
1a. Effect of individual factors Overall, the majority of students agreed that immunology is an important part of medicine and medical research with a mean score of 4.23 ± 0.65. High mean scores were also observed for appreciation (3.82 ± 0.88), usefulness (4.14 ± 0.57), and applicability (3.56 ± 0.85) of immunology. However, there was high congruence in their perception of the level of ease/difficulty of the subject with a mean score of 2.50 ± 0.84, indicating that the students felt it was a difficult subject.

1b. Correlation between factors All the factors had varying levels of positive correlations. Justification for studying immunology was positively and highly significantly (p < 0.001) correlated with the importance and relevance of the subject (r = 0.54 and r = 0.60 respectively). A highly significant (p < 0.001), positive correlation was also evident between enjoyment and level of understanding (r = 0.60) of immunology; enjoyment and appreciation of immunology in relation to pathology/medicine (r = 0.50); as well as level of understanding and appreciation of immunology (r = 0.57).
The level of difficulty of the subject did not correlate well with any of the other questions (Table 2).

Research Question 2: Differences in student perceptions of immunology, in relation to their gender, origin and year of study

Despite the diversity in the participant profile, there were no significant differences in the students’ perceptions of immunology, in relation to their gender and origin. There were also no significant interaction effects between the variables. Table 1 depicts values for only the factors with significant differences. The results showed significant ($p < 0.05$) year of study effect on students’ perceptions of the importance, usefulness and applicability of immunology, as well as their appreciation of the subject in their medical course. Perception of the importance of immunology was higher amongst the Year 1 students in comparison to the other year groups; it was significantly higher ($p < 0.01$) than that of the Year 4 students ($4.41 \pm 0.56$ vs. $4.00 \pm 0.65$ respectively).

Years 1, 2 and 3 students appreciated the study of immunology more than their Year 4 and 5 counterparts. Year 2 students appreciated the subject the most and Year 5 students appreciated it the least ($4.15 \pm 1.03$ vs. $3.53 \pm 1.06$). Year 1 students perceived immunology as most useful and Year 5 students found it the least useful when compared to all the other year groups, with mean scores ranging from $3.80$ – $4.28$. The Years 2 and 3 participants responded more positively to the applicability of immunology ($3.70 \pm 0.72$ and $3.75 \pm 0.75$ respectively), in comparison to the Year 5 participants ($3.13 \pm 0.74$).

Table 1

Mean scores (± standard deviation) of student responses to the survey questions*

<table>
<thead>
<tr>
<th>Year of Study</th>
<th>IMP</th>
<th>REL</th>
<th>FUS</th>
<th>OBJ</th>
<th>USE</th>
<th>EAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>$4.41 \pm 0.56$</td>
<td>$4.03 \pm 0.60$</td>
<td>$4.28 \pm 0.63$</td>
<td>$3.70 \pm 0.72$</td>
<td>$3.80 \pm 0.83$</td>
<td>$3.90 \pm 0.71$</td>
</tr>
<tr>
<td>1</td>
<td>$4.41 \pm 0.56$</td>
<td>$4.03 \pm 0.60$</td>
<td>$4.28 \pm 0.63$</td>
<td>$3.70 \pm 0.72$</td>
<td>$3.80 \pm 0.83$</td>
<td>$3.90 \pm 0.71$</td>
</tr>
<tr>
<td>2</td>
<td>$4.15 \pm 1.03$</td>
<td>$3.70 \pm 1.06$</td>
<td>$4.11 \pm 0.40$</td>
<td>$3.75 \pm 0.75$</td>
<td>$3.75 \pm 0.75$</td>
<td>$3.75 \pm 0.75$</td>
</tr>
<tr>
<td>3</td>
<td>$4.00 \pm 0.61$</td>
<td>$3.53 \pm 0.74$</td>
<td>$4.10 \pm 0.75$</td>
<td>$3.23 \pm 0.90$</td>
<td>$3.23 \pm 0.90$</td>
<td>$3.23 \pm 0.90$</td>
</tr>
<tr>
<td>4</td>
<td>$3.90 \pm 0.72$</td>
<td>$3.53 \pm 0.74$</td>
<td>$3.23 \pm 0.90$</td>
<td>$3.23 \pm 0.90$</td>
<td>$3.23 \pm 0.90$</td>
<td>$3.23 \pm 0.90$</td>
</tr>
</tbody>
</table>

Table 2

Pearson’s correlations between the Likert-type survey questions.

Research Question 3: Exploration of students’ learning experiences

In response to survey question 11 (What was/is your main motivation to study for immunology?), over half of the students ($n = 73, 55.7\%$) expressed a short-term goal of studying in order to pass their examinations/avoid failure. About a fifth of the students ($n = 26, 19.8\%$) were motivated to study by focusing on the long-term goal of graduating as a doctor, whilst approximately a quarter of the students ($n = 32, 24.4\%$) wanted to study in order to learn more about the immune system and/or for knowledge. None of the students felt that they needed to study due to peer pressure (Figure 1).

Figure 1

The primary motivation for studying immunology amongst medical students

In response to survey question 12 (What methods and resources did you use to learn your immunology?), 94 students (71.8%) indicated individual study as their most preferred study method, whilst 74 (56.7%) and 73 students (55.7%) preferred rote learning and visualisation respectively (Figure 1). Group study was a less preferred study method ($n = 48, 36.6\%$). In relation to study resources, the utilisation of lecture notes and textbooks were the most popular ($n = 84, 64.1%$ and $n = 94, 71.8\%$ of students respectively), whilst journal articles were the least used resource ($n = 4, 3.1\%$) as shown in Figure 2.
Table 3 summarises the recurring themes from the qualitative analysis in relation to the open-ended questions in the survey (questions 13-15). The qualitative data were categorised into six major themes namely: conceptualisation, relevance, depth of content/information load, learning difficulties, helpful resources and assessment issues.

Verbatim illustrative quotes from the students were also presented. Many of the issues raised were consistent with and provided more details about the quantitative findings. On the whole, the respondents found the teaching of immunology to be mostly focused on abstract information which did not signify any clinical relevance, with the teaching style merely fostering rote learning. They believed that only a basic knowledge of immunology is required for their medical career. However, the participants indicated that small group tutorial classes were helpful in addressing difficulties. They also suggested that only clinically relevant information which is appropriate to the year of study should be provided.

DISCUSSION

Factors that influence medical students’ perceptions of immunology

The majority of the students agreed on the perceived importance, justification and relevance of immunology to clinical medicine. The findings in this study are consistent with the limited published literature indicating that students find immunology difficult and fail to see its clinical relevance.5-7 This highlights the need for innovative teaching strategies and learning activities to promote the clinical relevance of immunology to medical students. Differences in student perceptions of immunology, in relation to their gender, origin and year of study

Despite the lack of formal teaching of immunology beyond the preclinical years, there was congruence on the perceived level of difficulty as well as the importance and relevance of immunology to clinical medicine across all years of study. However, this did not differ based on the gender or student origin, implying that irrespective of gender or origin, students within each year group had similar perceptions of the subject. One would have expected significant differences in the perceptions of domestic students versus international students, given that international medical students often face considerably more challenges over their domestic counterparts.12 Furthermore, the results revealed that, when compared to their pre-clinical counterparts, the students in their clinical years particularly did not find it as useful, important or applicable to their studies or career. This observed decline in enthusiasm may be attributed to the fact that as students progress through medical school, their knowledge of basic medical sciences diminishes;13 hence, forming connections with clinical and basic science may

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**Table 3**

Recurring themes from the survey

<table>
<thead>
<tr>
<th>Recurring Themes</th>
<th>Sample Comments</th>
<th>Year of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students felt the clinical relevance of what they studied and how to use medical material.</td>
<td>&quot;I think the content is quite difficult to understand and apply to clinical practice.&quot; (Year 1 student)</td>
<td>Year 1</td>
</tr>
<tr>
<td>Students felt the teaching was confusing and how to apply immunological concepts to clinical situations.</td>
<td>&quot;I found it very difficult to understand and apply the concepts to clinical situations.&quot; (Year 2 student)</td>
<td>Year 2</td>
</tr>
<tr>
<td>Students felt the teaching was too theoretical and clinical relevance was not emphasized.</td>
<td>&quot;The teaching was too theoretical and clinical relevance was not emphasized.&quot; (Year 3 student)</td>
<td>Year 3</td>
</tr>
<tr>
<td>Concerns about immunology in examinations.</td>
<td>&quot;I am unsure of where we need to go in immunology, i.e. what is relevant and what is not.&quot; (Year 2 student)</td>
<td>Year 2</td>
</tr>
<tr>
<td>Students felt the teaching was too theoretical and clinical relevance was not emphasized.</td>
<td>&quot;I feel the teaching was too theoretical and clinical relevance was not emphasized.&quot; (Year 3 student)</td>
<td>Year 3</td>
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<td>&quot;I feel the teaching was too theoretical and clinical relevance was not emphasized.&quot; (Year 3 student)</td>
<td>Year 3</td>
</tr>
</tbody>
</table>
become more challenging for them. It may also imply that students in their first few years of education do not have the experience or clinical exposure to determine if content being taught is important or justified in their medical education. Whereas, those in their clinical years have gone into application of knowledge and can therefore provide some thoughts on how they applied immunology concepts in the clinical settings. With the increasing role for clinical immunology in our society, a greater emphasis should be placed on highlighting the clinical relevance and applicability of this subject in medical practice. Therefore, a major goal for medical educators is to integrate a complex subject like immunology with the other areas of medical education as best as possible and emphasise its clinical relevance within a facilitating learning environment.

Exploration of students’ learning experiences

Whilst individual study and consultation of textbooks and lecture notes proved to be some of the most popular learning strategies in our study, group learning was not a popular study technique. Further studies will be required to clarify if the same study strategy is applied to other biomedical science subjects. Analogous to real-life clinical practice, teamwork and ongoing peer teaching are essential elements of PBL/CBL medical education. At one medical school, peer teaching had the added benefit of improving the academic performance of those who tutored. A respondent in this study remarked on the usefulness of tutoring juniors to their own education in immunology. Promoting group work and peer teaching have a number of desirable outcomes including promotion of teamwork; promoting critical and reflective thinking, encouragement of students to take charge of their learning, improved communication skills and for the teaching student, increased retention of information and development of an academic sense of the health professional as a teacher.

Respondents found the teaching of immunology to be mostly focused on abstract information which did not signify any clinical relevance, with the teaching style merely fostering rote learning. This finding is congruent with an earlier study that found decreased knowledge in such theoretical subjects and increases in more clinically-oriented subjects such as pathology and pharmacology. The reported declined in perceived relevance of the subject area, particularly in the clinical years, calls for further integration of immunology into clinical teachings.

This study is limited by a relatively lower than expected response rate (22.7%) which may be due to a likely combination of factors, including disengagement with the subject of immunology and no incentive offered for survey participation. This is also an inherent general disadvantage of online surveys; but nonetheless, a valuable trade-off for the rapid method of data collection. In addition, this was a single study, conducted at one institution. In spite of these, the major strength of our study is the fact that it is the first systematic and detailed exploration and quantitative evaluation of the learning experiences and perceptions of medical students across all year groups, to immunology as a discipline. It is also congruent with the current limited literature in this area; nonetheless, further work is required to confirm the generalisability of our findings.

In relation to our findings on participants’ learning experiences, the following are some recommended strategies:

- An issue highlighted in the study was the applicability and clinical relevance of the discipline, with only 29% of the respondents utilising clinical cases to aid their study. This indicates the need for reinforcement of basic immunology teaching particularly in the clinical years with clinical cases that highlight basic immunological principles.
- Our study revealed that some students learnt or revised their immunology through tutoring peers. Hence, encouraging senior students to participate in junior year teaching as tutors may help them to understand the relevance of the subject, as well as consolidate, retain and apply the basic science knowledge gained to their own clinical learning.
- Some of the respondents commented on the value and usefulness of multimedia and animation in their learning. In a highly computerised world, the adoption of innovative computer programmes to enhance and complement traditional face-to-face immunology teaching should be strongly considered.

CONCLUSION

The results of our study indicate that medical students find immunology complex and difficult to relate to clinically. This finding was consistent across all year groups and did not differ based on the gender or student origin. Immunology is perceived by medical students to be conceptually difficult to relate to, with decreasing relevance and applicability in clinical settings; therefore active measures should be taken to support and encourage learning. Further studies should explore innovative ways of teaching immunology to retain its relevance and motivate lifelong learning.

ACKNOWLEDGEMENTS

We gratefully acknowledge the students who participated in
this study. We also thank Mr Phillip Patman for statistical advice.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

APPENDIX 1. SURVEY QUESTIONS.

Appendix 1

Survey questions

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