

## Attitudes of Australian Chiropractic Students towards Anatomy and Chemistry

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**ABSTRACT** Education of chiropractic students has traditionally been based on a good grounding in basic sciences. However, the place and significance of these disciplines in chiropractic education, as well as student, staff and clinician attitudes towards them have been rarely investigated. In this study, the attitudes of Macquarie University chiropractic students towards anatomy and chemistry were examined, using a modified version of the questionnaire previously used in a survey of medical students in the UK and France. Pearson's chi-square test and logistic regression were used in data analysis. The results suggest that chiropractic students recognize anatomy as a very important subject in their education while chemistry is perceived as a subject of lesser importance. Several factors are suggested as reasons for this difference. Chiropractic is a health profession focused on musculoskeletal disorders, for which manual therapy is the major treatment approach, and this makes the importance of anatomy almost self-evident. It is also argued that the other major factor influencing students' attitudes is the way anatomy is currently taught at Macquarie University and other chiropractic schools in Australia. Following the recent evolution in anatomy education for health professionals, anatomy has become better integrated within the chiropractic curricula with strong applied and clinical focus. This indicates that an efficient integration of basic sciences into a chiropractic or other health profession curricula could contribute towards the better and easier recognition of their importance among the student body.

### INTRODUCTION

The education of the majority of health professionals usually starts with basic sciences such as physics, chemistry and biology followed by anatomy and physiology. These pre-clinical disciplines are essential in providing students with a good understanding of the human body at all levels of its organisation and function as well as the ways in which it interacts with the environment. This knowledge is expected to impart a necessary basis for the development of clinical skills and competencies.

The role of all basic sciences within the constantly evolving curricula of health practitioners is continually examined and debated (Dienstag 2008; Bergman et al. 2011; Nouns et al. 2012; Prober et al. 2012; Bandeira et al. 2013; Baroffio et al. 2013; Schaubert et al. 2013; Eisenstein et al. 2014). As a result, the education in basic sciences for health professionals has changed significantly in recent years, especially within the prob-

lem based learning paradigm. The attitudes, perceptions, and opinions of principle stakeholders, the students in particular, are of special importance in this complex process of curriculum transformation

Chiropractic is a health profession which has been characterised by strong educational programs in basic sciences since the 1920's (Keating et al. 2004). In Australia, chiropractic is currently taught at government funded universities as a five-year degree. At Macquarie University, where this research was carried out, the chiropractic program is comprised of a three year undergraduate and a two year postgraduate degree. The undergraduate study places an emphasis on basic science education with a concurrent gradual introduction in the clinical disciplines. The emphasis in the postgraduate study is on clinical subjects through which some revision of the knowledge in basic sciences is carried out.

Anatomy and chemistry have traditionally been among the key pre-clinical disciplines within the chiropractic curricula. At Macquarie, these two subjects are studied in the first two years of the undergraduate program. In the first year, students take one or two semesters of chemistry depending on their level of high school chemistry. They also have four compulsory one-semester anatomy units (modules).

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There have been some indications, however, that these two subjects might be at the opposite ends with regards to students' perception of their importance for developing clinical skills. Anecdotally, from informal conversations with graduates and fellow academics, students seem to acknowledge the importance of anatomy in developing core clinical and professional competencies while they tend to question the relevance of chemistry. Furthermore, research conducted in other countries suggests that medical students appreciate highly the importance of anatomy but have relatively low opinion on chemistry (Pabst and Rothkötter 1996; Pabst and Rothkötter 1997; Moxham and Plaisant 2007; Plaisant et al. 2014).

There are, however, no studies that have examined chiropractic students' attitudes towards basic sciences in general, or anatomy and chemistry in particular. The aim of this study was to investigate chiropractic student attitudes towards these two pre-clinical subjects. It is hoped that the results could be used when planning chiropractic curricula and delivery modes in basic sciences.

### METHODOLOGY

A survey was conducted on a sample of chiropractic students at Macquarie University. The questionnaire ([http://chiro.mq.edu.au/Research/projects/Anatomy\\_and\\_Chemistry\\_Questionnaire\\_September2013.pdf](http://chiro.mq.edu.au/Research/projects/Anatomy_and_Chemistry_Questionnaire_September2013.pdf)) was a modified version of the one previously used by Moxham and Plaisant (2007). The original questionnaire consists of 20 statements concerning the importance of anatomy to clinical medicine. All statements are weighed from 1 - extremely favourable (for example, "Medicine could not exist without anatomy") to 11 - extremely unfavourable (for example, "Anatomy is time wasted in the medical curriculum"). In the questionnaire used in this study "medicine" was substituted with "chiropractic" and another set of statements in which "anatomy" was substituted by "chemistry" was added. Students who participated in the survey were given the questionnaire with twenty equivalent statements on the importance of anatomy and chemistry, respectively. They were asked to tick the statements with which they fully agreed. Information collected in this survey also include student's gender, age, previous degree (yes or no), origin (domestic or international) and first language (English or other).

Following the recommendations on surveying health professions students (Pabst et al. 2001; Pabst 2009), for this survey the researchers recruited students currently enrolled in different levels of the chiropractic program. The researchers surveyed first year students who were at the beginning of their studies (but completed their first anatomy and chemistry units) as well as those in the third (final undergraduate) and fifth year (final postgraduate).

This survey was anonymous and voluntary. All questionnaires were distributed by research assistants. The study was approved by the Macquarie University Human Research Ethics Committee.

A bar chart was used to illustrate the patterns of the students' responses to the 20 statements. Eight of the 20 statements were clearly positive (statements 14, 2, 10, 12, 13, 3, 16 and 20), seven were somewhat positive (coded as limited) but the remaining five were clearly very negative statements. Based on this, an attitude measure/variable was established, in which positive attitude (yes or no), towards anatomy and chemistry respectively, was defined as having agreed with at least one of the eight clearly positive statements. Pearson's chi-square test was used to evaluate the association between each study factor of interest and the positive attitude. Factors studied include year in the chiropractic program, gender, age, previous degree, origin and first language. Logistic regression (Agresti 2002) was used to ascertain the association of the positive attitude with each factor, while accounting for the effects of the other factors.

All analyses of data presented here were carried out using the Statistical Package for Social Sciences (SPSS), and a 5% significance level was used in this study.

### RESULTS

Out of 317 students enrolled into the first, third and fifth year of chiropractic studies in 2012, 168 students completed the questionnaire, with a response rate of 53%. Of them, 11 students gave contradicting responses, agreeing with both extreme positive and negative statements, and thus were removed from the analyses presented in this paper. Among the 157 students included, 67 (42.7%) were first year, 34 (21.7%) third year and 56 (35.7%) fifth year students, similar to the distribution by year of the overall 317

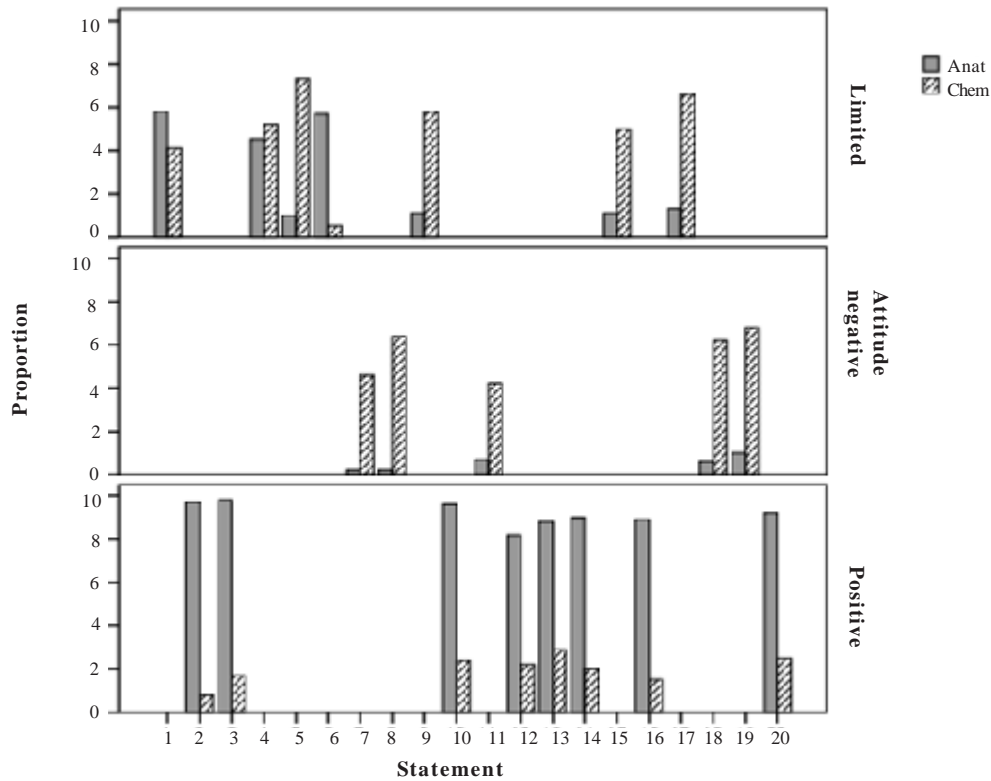


Fig. 1. Summary of students' attitudes towards anatomy and chemistry

students in the program. Also, there is fair presentation of both genders and age groups in this sample. This group of 157 students is thus considered a reasonably representative.

The responses, of the 157 students included in the study, to the 20 statements about anatomy and chemistry, respectively, were summarised and presented in Figure 1, with respect to the three broad attitude categories of positive, limited and negative, as defined in the methods section. It is clear that the students were more positive about the importance of anatomy to chiropractic in comparison to that of chemistry. Proportion of the students who agreed with each of the positive statements is much higher towards anatomy than chemistry, but a much higher proportion of them agreed with each single very negative statement (7, 8 and 11) or quite negative statement (18 and 19) towards chemistry.

In fact, all 157 (100%) students, disregarding gender, age, and other demographic factors, had agreed with at least one of those clearly positive

statements about anatomy and thus were considered as having positive attitude towards anatomy, that is, believing in the importance of anatomy education in chiropractic profession. However, not all students had positive attitude about the importance of chemistry. The patterns of attitude towards the importance of chemistry were summarised in Table 1. Students in their fifth (final) year of the chiropractic program were slightly more likely to have positive attitude towards chemistry than those in their first year, 60.7% vs. 58.2%, and females had a higher likelihood to be positive towards chemistry than males, 66.2% vs. 53.8%. Also, being older, being an international student, and having a previous degree or first language other than English, appeared to be associated with more positive attitude towards chemistry, although none of the differences in the percentage of the positive attitude was statistically significant ( $p$ -values  $> 0.05$ ). Those observed differences were further ascertained using logistic regression, allowing for other co-

**Table 1: Students in the sample studied**

<i>Factor</i>	<i>N</i>	<i>% positive attitude towards chemistry</i>	<i>P-value*</i>
<i>Grade</i>			
Year 1	67	58.2	0.96
Year 3	34	58.8	
Year 5	56	60.7	
<i>Gender:</i>			
Female	65	66.2	0.123
Male	911	53.8	
Missing	1	53.8	
<i>Age</i>			
< 20 years	43	53.5	0.25
20 – 25 >	80	57.5	
25	29	72.4	
Missing	5	72.4	
<i>Previous Degree</i>			
Yes	39	61.5	0.632
No	112	57.1	
Missing	6		
<i>Origin</i>			
Domestic	138	58.7	0.845
International	18	61.1	
Missing	1		
<i>First Language:</i>			
English	132	57.6	
Other	24	66.7	
Missing	1		

\* P-values in this table are based on analyses without including missing group.

variates (potential confounding factors). Note that there were a few (1 to 6) missing values (responses) in some factors studied as shown in Table 1, which were not included in the logistic analysis presented in Table 2.

As shown in Table 2, except for gender, none of the factors studied were significantly associated with attitude towards chemistry, even after controlling for possible confounding effects from other factors. Females had significantly higher likelihood of the positive attitude (p-value = 0.034)

than male students, having at least 6% greater odds or chance (estimated odds ratio = 2.182 with 95% confidence interval of 1.06 to 4.48) believing the importance of chemistry in chiropractic profession. After accounting for the effects of gender and other factors, there is still no significant difference in the attitude towards chemistry among students across the year (that is, stage) of the program, age groups, being an international student (or not), having English as first language (or not), or whether having a previous degree (p-values > 0.05).

## DISCUSSION

The results show a great difference between students' attitudes towards anatomy and chemistry among chiropractic students at Macquarie University. While chemistry was seen as a subject of less relevance for clinical studies, anatomy was perceived as a discipline of considerable importance by all students. There were no significant differences in students' attitudes towards chemistry with regards to their age, country of origin, and year of study. However, female students were more likely to have positive attitude towards chemistry although, in general, their attitude towards chemistry was still less positive than their attitude towards anatomy.

Similar results came out of research focusing on medical students. In a survey of German final-year medical students only 8% of respondents thought chemistry to be fundamental to medical study while 48% thought that it was necessary (Pabst and Rothkötter 1996). In contrast, gross anatomy was thought to be fundamental by 91% of the respondents and necessary by 8%, microscopic anatomy fundamental by 66% and necessary by 30%, and neuroanatomy fundamental by 60% and necessary by 30%. Furthermore, it was noted that students' attitudes

**Table 2: Logistic regression of positive attitude towards chemistry**

<i>Factor</i>	<i>B</i>	<i>S.E.</i>	<i>P-value</i>	<i>Odds ratio</i>
<i>Year: (Year 1 as ref<sup>o</sup>)</i>				
Year 3	0.224	0.469	.633	1.251
Year 5	0.082	0.476	.863	1.086
<i>Gender: (Male as ref<sup>o</sup>)</i>				
Female	0.780	0.368	0.034 (< 0.05)	2.182
<i>Age: (&lt; 20 as ref<sup>o</sup>)</i>				
Age 20-25	0.343	0.489	.484	1.409
Age > 25	1.173	0.631	.063	3.233
<i>Have Pre-degree: (No as ref<sup>o</sup>)</i>				

towards pre-clinical subjects were influenced by their planned field of specialisation.

Moxham and Plaisant (2007) measured attitudes of medical students at various stages of their studies - the beginning, immediately after completing the anatomy course and in their final year. They surveyed students in Britain and France, at Cardiff University and Paris V (Université René Descartes) respectively. The study suggested that "students at all stages of their medical course share with professional anatomists the view that anatomy is a very important subject for their clinical studies" (Moxham and Plaisant 2007: 560). These findings were further corroborated in a follow-up study which focused on a bigger and more heterogeneous sample of students. A survey of medical students from the UK, France, Granada and Turkey revealed that the respondents had "strongly supportive views concerning" anatomy's importance in medicine (Plaisant et al. 2014: 261).

Furthermore, similar attitudes seem to characterise physicians. In a survey of German medical doctors at the end of their specialisation, medical chemistry was valued as fundamental by 4% of the respondents and as necessary by 48% doctors (Pabst and Rothkötter 1997). At the same time, gross anatomy was thought to be fundamental by 86% of the respondents and necessary by 13%, microscopic anatomy fundamental by 48% and necessary by 40% and neuroanatomy fundamental by 33% and necessary by 47%.

Research also suggested that chemistry might be one of the major obstacles and a "weeding" agent in medical studies. In the USA, for example, difficulties with learning chemistry are seen as one of the major reasons why students attending premedical programs decide not to enter medicine (Barr et al. 2010).

It could be argued that there are several reasons for the attitude difference towards anatomy and chemistry among the Australian chiropractic students. Difficulty in learning chemistry, which appears to be a major impediment for many medical students in the USA, as mentioned before, may be one of the reasons although probably of a lesser importance among chiropractic students. Both anatomy and chemistry at Macquarie University have relatively high but are not significantly different in failure rate between the two subjects. Indeed, in both subjects, a number of innovative learning activities were introduced to improve students' performance,

such as peer assisted learning sessions. The reasons for the attitudinal difference may also be sought in the nature of the two subjects and the way they are taught.

Chiropractic is defined by the World Federation of Chiropractic (2001) as "*a health profession concerned with the diagnosis, treatment and prevention of mechanical disorders of the musculoskeletal system, and the effects of these disorders on the function of the nervous system and general health. There is an emphasis on manual treatments including spinal adjustment and other joint and soft-tissue manipulation*". It would appear that, in a profession focused on musculoskeletal disorders and utilising primarily manual therapy, the relevance of anatomy as compared to chemistry is easier to be perceived. Therefore, one might expect that anatomy would always provoke more positive response among the students of chiropractic. One would also expect that chiropractic students are likely to be even more positively orientated towards anatomy but more negative towards chemistry than medical students, especially those medical students who are interested in specialisation in non-surgical disciplines.

Furthermore, the way anatomy curriculum is structured and delivered also appears important. Anatomy was one of the subjects that endured heavy criticism for its apparent inability to evolve (Turney 2007), stubbornly focusing on irrelevant details while neglecting clinical applications. However, as a result, at least partially, of this criticism, anatomy education has endured many changes in recent years, and anatomy is becoming more "user friendly" and clinically relevant discipline (Drake et al. 2009; Louw et al. 2009; Sugand et al. 2010; Štrkalj in print). Modern anatomy programs tend to focus primarily on the final outcome of the education in health disciplines, that is to produce a competent clinician.

At Macquarie, anatomy curriculum had recently undergone many changes following the latest trends in basic science education for health professions. A new anatomy program was constructed and introduced in 2010, to cater for the specific needs of chiropractic students (Štrkalj et al. 2012a). Clinical and applied aspects of anatomy as well as medical imaging and surface anatomy gained more prominence in this new program. Chiropractic academics played an important role in building this new curriculum and they were invited to deliver some of the lectures. In

addition, a number of clinicians are currently acting as tutors/teaching assistants in the related laboratory practicals and tutorials. Similar changes in anatomy have also been implemented in anatomy curricula in other chiropractic schools in Australia (Štrkalj et al. 2012b).

Chemistry teaching, on the other hand, has changed very little within the Macquarie University chiropractic curriculum, and this might be one of the reasons for student's failure to understand its importance within the clinical context. Chemistry is currently taught by a service department, to satisfy the needs of a wide range of students from different disciplines. While, as noted earlier, chemistry probably never be perceived as important as anatomy by chiropractic students, their rather negative opinion of the subject should, perhaps, also be understood as a sign that chemistry within the chiropractic curriculum needs to undergo change in the same way as anatomy has. Following Dienstag's (2008: 222) recommendations, chemistry should move towards "a greater efficiency and a tighter focus on science that 'matters' to medicine" or, in this case, that matters to chiropractic discipline.

Better integration of chemistry within the chiropractic curriculum is therefore imperative because only within the clinical context can the importance of chemistry be fully acknowledged (McRae 2012). This might not always be an easy task as the existing university structure and organisation in many countries may represent one of the crucial obstacles for making basic science subjects specific to a health curriculum. For example, chemistry is often taught to students from various disciplines by a service department or as a part of a pre-medical education. Indeed, one of the reasons why anatomy is so well integrated in the chiropractic curriculum at Macquarie University is the fact that anatomists have always been based in the chiropractic department. This is not the case for academics in chemistry. Although challenging, solutions should be constantly sought to forge interdepartmental collaboration which would facilitate and improve the integration of basic sciences into the chiropractic curriculum.

One of the main characteristics of a good curriculum is its ability to evolve following the advancements in relevant disciplines and educational research. Better integration of some of the traditionally "problematic" basic sciences, such as chemistry, into chiropractic curriculum

is one of the most important challenges. Perhaps it is one of the biggest challenges to overcome the constraints of the compartmentalisation of modern academia and enthuse the academics from different departments and faculties to work towards a common education goal, a better chiropractic program.

All students included in this study had positive attitude towards anatomy. Except for gender, no other demographic factor was found to be significantly related to students' attitudes towards chemistry. Female students tend to be more positively inclined towards chemistry. It is, however, not clear what are the reasons for this difference. Further studies, including those utilising qualitative approach such as interviews with students, might shed more light on this issue (*cf.* Campos-Sanchez et al. 2014).

This study had some limitations. The sample size was effectively only 157, which is considered quite small for this study with a binary response variable, positive attitude (yes or no). For example, it would only give less than 50% power to detect a true difference of 15% in the positive attitude. Given the relative low power of the study, one should be reasonably confident about the gender difference in the attitude towards chemistry identified in the current study. On the other hand, the fact that the large differences observed by age groups and some of other factors were not shown to be significant in this study is likely due to, at least partially, the small sample size. Therefore a further large study is necessary to ascertain the age and other effects on the attitude towards chemistry.

## CONCLUSION

This study suggests that Australian chiropractic students' have different attitudes towards the importance of anatomy and chemistry in their education. While anatomy is seen as highly relevant, chemistry is perceived as a subject of relatively low importance. Differences in attitude towards the different basic sciences should be considered attentively as they might have implications in students' overall performance and learning experience. One of the reasons for the attitudinal divergence might be the differences in the level of integration of particular basic sciences into the chiropractic curriculum. Measures should be taken to streamline basic sciences towards clinically more relevant learning objec-

tives, to meet the needs of the modern chiropractic curricula.

### RECOMMENDATIONS

Basic sciences constitute a backbone of chiropractic education. Students' failure to perceive the importance of some of these sciences can have negative implications on their performance and should be addressed.

It is argued here that an efficient integration of basic sciences into chiropractic and, indeed, other health profession curricula is an imperative. Such an integration could facilitate a better recognition of these subjects' importance among the student body. It is therefore suggested that there should be a strong emphasis on the clinical and applied components when teaching all basic sciences and in particular those which traditionally have not had these components significantly present, such as chemistry in chiropractic education. It is also suggested that basic sciences should be revisited in the later years of study. These measures could potentially improve students' performance and the quality of their learning experience.

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