

Student learning of anatomy

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Abstract: *Relationships between student approaches to learning and learning outcomes were explored in a population of first year students studying anatomy in a medical program offered by a research intensive Australian university. An online survey version of the Study Process Questionnaire (Biggs et al, 2001), examination scripts and student results were the source data for this study. These students showed high Surface Approach (SA) scores (Mean 30+3.4) and Deep Approach (DA) scores (Mean 28+4.2) using the Revised two-factor SPQ. The quality of pieces of work written in their examination was rated using the Structured Observed Learning Outcomes (SOLO) taxonomy (Biggs & Collis, 1982). There was no correlation between SA and DA scores and mean SOLO ratings. However, there were significant correlations between SA scores and final grades (0.3, $p < 0.01$) and between mean SOLO ratings and final grades ($r = 0.61$, $p < 0.01$) in the course. Further work exploring exactly how students approach study will be useful to elucidate the roles and distinctions between SA and DA in learning anatomy.*

Keywords: *approaches to learning, SOLO taxonomy, anatomy*

Introduction

Student approaches to learning theory (Biggs, 2003) has become the foundation underpinning the conceptualisation of teaching and learning in higher education and emphasises the importance of student perceptions and behaviours in the teaching and learning process. Student conceptions of learning may change slowly, but their approaches to learning are dynamic, changing in response to their learning environment (Ramsden, 1992). They are influenced by a range of factors including students' past experience, perceptions of the task, their own values and motives, classroom environments and teaching methods (Biggs, 1993).

Depending on the context, students may adopt strategies that reflect surface or deep approaches to learning (Marton and Saljo, 1984). In their exploration of students' approaches to learning through reading of text they observed that students who failed to understand the text were using an approach that almost excluded the possibility of understanding. This surface approach to learning was associated with an intention to memorise and recite facts back in response to questions. There was no intellectual

engagement with the subject matter, except at the most trivial level. Other students however adopted an approach where they attempted to understand the text by considering the author's message, by seeking a structure within the material and manipulating the information to make sense of it in relation to what they already know of the subject matter. These two approaches to learning are not stable traits; students may choose different approaches at different times, or a combination of approaches depending on the nature of sub-tasks and context.

The study of anatomy is problematic for students. It involves the knowledge of structures of the parts of the body, their physical organization, function and structural and functional relationships with each other. The first challenge many students face is an overwhelming amount of new terminology and number of anatomical structures that, at one level, need to be known before they can even communicate with peers and tutors. Memorisation is one strategy used to overcome this hurdle and could be used in both surface and deep approaches to learning anatomy. It seems that for many students knowledge of the disciplinary jargon is their learning endpoint, they never develop a language of anatomy or reach a deeper understanding of how the body is organized and functions as a foundation for medical practice.

The quality of learning

There is growing body of evidence that relates how students learn to what they learn. Balla, et al. (1990) demonstrated that medical students who used listing approaches to symptoms were less likely to make a diagnosis than students who sought to see relationships between symptoms. Approaches to learning are also strongly correlated with the quality of learning outcomes. Boulton-Lewis (1994) found that students with a more structured organisation of knowledge were more concerned with deep strategies than those with less organised conceptions of learning. The relationship between approaches to learning and academic achievement can be seen in studies of psychology students (Newstead, 1992) and business students (Sadler-Smith, 1997) where academic performance correlated significantly with a deep approach to learning.

Teaching and learning context

Anatomy is the study of the structure of the human body and gross anatomy is the study of the parts of the body as seen by the naked eye through dissection. Over time the traditional learning about the human body has been reduced to learning by prosections, and by use of models. Until 2003, Gross Anatomy had been taught as a course within the pre-clinical years to students in medicine and contributes to 37% of the final course in Anatomy 1 (Pandey & Magin, 2003). The investigation reported in this study was conducted in Session 2 of 2003, the last year of a traditional medicine curriculum. The course (taught by PP) enrolled over 200 students. Teaching within the course was a regional approach with 4-hours of formal tuition scheduled for each week of the semester consisting of one 1hr lecture, and one 3hr tutorial groups operated with 16-20 students in each group. The students attend the lecture one week and attend the tutorial classes in the following week. The teaching is intended to focus on and co-ordinate with pre-assigned learning activities. Each tutor is expected to organise his/her teaching accordingly, so tutorial sessions are not consistent across all groups. Students are expected to do some work for themselves towards the end of the tutorial. The reality is that, for the past several years, much of the activity in tutorials is basically 'mini-lectures' by the individual teacher providing information not covered in the lectures, further explanation of topics covered, or demonstrations using wet specimens or models. The assessment was held during the examination period at the end of term and consisted of practical (15%) and theory (22%) examinations. The theory examination during 2003 included 50 multiple-choice questions and 3 written essay questions and 10 short answer questions to assess the lateral thinking and applicability of anatomical concepts to the clinical and real life situations.

The aim of this research

The aim of this research is to examine student learning of anatomy. Anatomy is a discipline with its own language that is used to describe the organization and many structures of the body and requires considerable intellectual effort to identify the various structures and their internal organisation, as well as to ascertain their relationships with other structures of the body. Students' responses to the volume of information in anatomy textbooks and traditional teaching methods involve spending long hours memorizing anatomical terms without seeing the bigger picture of anatomical function (Shigeoka et al, 2000). The purpose of this research was to explore what role memorization played in student learning of anatomy, and whether indeed memorization was the primary requirement for quality learning outcomes and good grades.

Methodology

Students' self-reported study approaches with various resources and their responses to the Study Process Questionnaire (R-SPQ-2F, Biggs et al, 2001) were collected using a survey conducted within the regular cycle of evaluation of the anatomy course. Other open-ended questions also focused on their conception of anatomy. The voluntary survey was conducted after completion of teaching, but before the final examinations in the course, using www.SurveyMaker.com.au a website that generates online surveys with a range of automated email and reporting features. The questionnaire was voluntary and administered in closed, confidential mode, hence all students that participated in the study did so after explicitly providing consent. The online survey was attempted by 109 of the 217 (50%) students who were available to complete the survey. Surveys with incomplete data were removed from the dataset, leaving a total of 97 complete cases for analysis. Numerical data was analysed using SPSS (v. 12).

Survey Instruments

Approaches to learning

The Study Process Questionnaire was designed to shed light on teaching-learning relationships in classrooms. In this study we administered the short form of the Study Process Questionnaire R-SPQ-SF to distinguish between surface and deep learning approaches. The SPQ data were treated according to recommendations by Biggs et al (2001) and scale sub-scores and Surface Approach score (SA) and Deep Approach score (DA) were calculated accordingly. The maximum subtotal score for SA and DA is 20, whereas the overall score which involves summing of more items has a maximum of 50.

Quality of learning outcomes

The final examination in the anatomy course involved a number of open ended questions requiring short answers or a short essay. Students' answers to these questions were rated 1 to 5 according to the levels of the SOLO taxonomy (Biggs & Collis, 1982) by two independent markers according to a pre-negotiated understanding of the different levels of the taxonomy (Zimitat & McAlpine, 2003). SOLO 1 referred to the pre-structural level and whilst SOLO 5 referred to the Extended abstract level. The ratings from the two makers were compared and where there were discrepancies, the markers were asked to discuss their rating and come to a consensus on a final rating.

Academic performance

Examination results as percentages and final grades in the Anatomy course were used as the primary measure of academic achievement.

Results

The calculated scores from students' responses to the SPQ showed that the great majority of students in this course had both high Surface Approach scores (SA scores) and high Deep Approach scores (DA). The mean sub-scores and SA and DA scores are illustrated in Table 1. The relationship between SA and DA scores is illustrated graphically in Figure 1. It is worth noting that the mean DA score is lower than the SA score and that for most students (65%) their SA score was greater than their DA score.

Students' SA and DA scores were analysed in relation to their raw percentage marks in the subject and their final grade. However, there was a significant negative correlation between SA scores and their final raw percentage ($r = -0.300$, $p < 0.01$) in the course. There was, however, no significant correlation between SA and DA scores and final grade in the course.

	Mean Sub-score	Total Score
Surface Motivation	14 + 2.1	30 + 3.4
Surface Strategy	16 + 2.0	
SURFACE SCORE (SA)		
Deep Motivation	14 + 2.6	28 + 4.2
Deep Strategy	17 + 2.9	
DEEP SCORE (DA)		

Table 1. Student Approaches to Learning (from R-SPQ-2F). Subscore total =20, Total score =50.

Quality of learning outcomes

Student answers to four short answer examination questions were rated independently by two reviewers according to the quality of their answers as described by SOLO (Table 2). Of the 12 students with Mean SOLO levels greater than 4.0, 8 (75%) had DA scores greater than their SA scores. Overall, low level outcomes (i.e. Pre, Uni or Multistructural) were demonstrated by 65 of the 97 students, whilst high level outcomes (Relational or Extended abstract) were demonstrated by just 12 of the 97 students. There were 60 students who produced answers rated at SOLO level > 4 on at least two questions and of these 60 students, 37 (61%) had DA scores greater than their SA scores. There was no correlation between Mean SOLO Level and SA score or DA score. However there were significant correlations between Mean SOLO score and final raw percentage in the subject ($r=0.683$, $p < 0.01$) and the final grade awarded for the subject ($r=0.654$, $p < 0.01$).

SOLO Level	Rating	No. of Students	Mean SA Score	Mean DA Score
Pre-structural	1	13	31.5	26.5
Uni-structural	2	31	20.4	26.4
Multi-structural	3	20	30.5	28.3
Relational	4	11	28.0	28.5
Extended Abstract	5	1	33.0	27.0

Table 2. Mean SOLO ratings of student answers to the four examination questions and Mean SA and DA scores for those students.

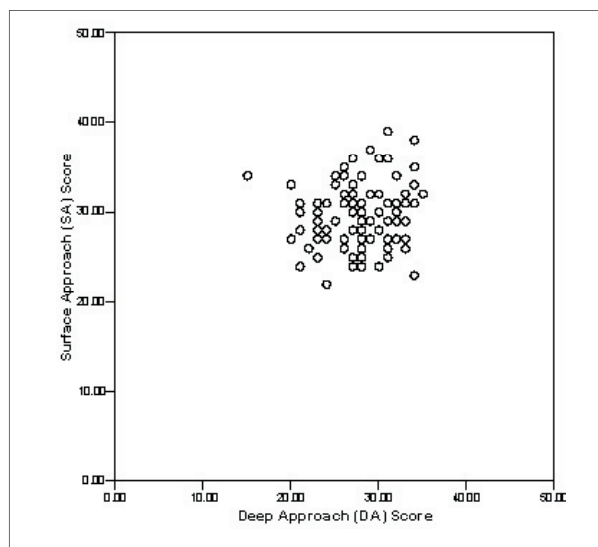


Figure 1. Plot of SA (Surface scores) vs DA (Deep scores) for first year students (n=97) studying anatomy in Medicine I.

Discussion

The most interesting finding from this study was students' great reliance on both surface learning approaches and deep learning approaches to learning anatomy, with a general over-emphasis on surface strategies. The over-emphasis on surface learning approaches appeared to be associated with lower quality learning outcomes based on SOLO ratings, and correlated with poorer exam performance.

Surface learning approaches and deep learning approaches have never been claimed to involve mutually exclusive strategies, but are two general categories that encompass a range of different learning strategies. Some students use memorisation strategies as part of an overall deep learning approach. Such students might read sections of text to understand them, and then write some notes before committing what they had learned to memory (Kember, 1996). Thus in the case of learning anatomy, students might read the text, generate a mnemonics that are committed to memory and develop an understanding that relies on the mnemonics to remember detail. The mnemonic forms part of an information base from which students can articulate their understanding about a particular structure or its function. For the students in this course, it is possible that more time was spent generating and memorizing mnemonics than was spent understanding the relationships between elements referred to in the mnemonic. Given the deep/surface model, this explanation is not unreasonable, and would explain also relationships between learning approaches and mean SOLO scores where students with $DA > SA$ scores tended to have higher mean SOLO ratings of their written work.

Bigg's SPQ frames our study in the deep/surface approaches to learning model, but other models could be useful to consider for further work. Since anatomy relies on an understanding of organizing principles, Pask's (1976) serialist and holistic learning strategies which describe the role of organizing frameworks in the learning process seem appropriate. Serialist strategies involve aggregation of the methodical step-by-step learning of details of topics to build a framework for understanding, whereas Holistic strategies involve ascertaining the big picture and searching for organization and structure within that framework to support understanding. According to Pask, an imbalance between the two strategies leads to characteristic learning failures. Serialists may memorise details, but fail to make connections and

establish relationships between concepts, structures and functions and so would not be able to answer questions at SOLO Level 3. They memorise facts but do not have an organizing framework. Holists on the other hand may have a general framework for understanding of a concept, but through a process of simplification are never be able to articulate details and are left with a hollow shell. They could answer questions at SOLO Level 3, but their ability to extend beyond that might be limited by their ability to see linkages between frameworks that prevents integration. Evaluating the most appropriate model/s can not be explored further until more information is available about the nuts and bolts of how students went about studying anatomy and the resources they used in the process.

Considering course revisions

The high surface approach scores relative to deep approach scores are consistent with a curriculum that encourages surface learning approaches. Ramsden (1992, p. 81) suggests that a syllabus overloaded with content, assessment that promotes recall of factual knowledge, limited feedback on progress and lack of independence in studying are key elements of courses that promote surface learning strategies. This is not to say that the course is devoid of methods that encourage deep learning, but that students perceive academic success to come through surface approaches at the expense of deeper learning approaches. The recent introduction of a study guide and peer group work in this course has helped students to make connections between theory, diagrams and specimens by communicating their understanding to others in a climate where learning from mistakes is freely allowed (Pandey & Magin, 2003).

It can be concluded from the data produced in this study that students perceive that surface learning strategies, such as memorization, making lists and the use of mnemonics etc are important aspects of studying anatomical science. This study was not designed to shed light on the extent to which various surface strategies might be useful. Biggs (2003) and Ramsden (1992) both argue that students' approaches to studying are largely responses to their "perception" of what is necessary for success in the course. Revising this course further should perhaps focus on ways in which students can learn to organise and manage anatomical information as part of a process of understanding anatomical problems that places less emphasis on detail. The use of problem-based learning as a curriculum strategy for learning anatomical science in medicine may assist in this regard, though the quality of student learning outcomes is still seen by some as problematic (Prince, et al, 2003).

This would take pressure of the burden of information overload that can drive surface learning approaches (Ramsden, 1992). Eizenberg (in Ramsden, 1992) suggested re-organising his anatomy course to make clear the coherent hierarchies of gross, macroscopic and microscopic structures and organization of the body and tissues. One approach might be guided practical project work where students undertake an exploration of a cadaver/specimen/skeleton to ascertain specific details of function, or some anatomical problem, that allows the focus to move from memorizing anatomical names towards understanding function. Students do have to learn to identify anatomical structures, but it can be done in the process of this type of anatomical research project. Supporting this notion, would be the development of other research skills in the curriculum through questioning in tutorials and formative assessment, such as the ability to analyse anatomical specimens (determine the gender of this skeleton), establish relationships (rebuild this skeleton), apply anatomical knowledge to clinical practice (how would you test ulnar nerve function), to hypothesise (what sort of muscle fibers would you expect in migratory birds?) or to create (how would you design a limb with this range of movement?).

Further work

These suggestions regarding curriculum renewal are perhaps premature, without a better understanding of exactly how students approach learning anatomical science. The student responses to the SPQ provide

only one measure of their approaches to learning within one model. There are many resources provided to support student learning in this course and it would be useful to interview students to see how they use these resources, or to observe their approaches to using laboratory specimens to aid their learning. This would help to clarify the relationship between surface approaches (such as memorization) and deep approaches (such as correlating information in notes and diagrams with use of cadaveric specimens) to learning anatomy in the context of this course.

Conclusions

The findings of this study support the widely held view that students studying anatomy place a heavy emphasis on the use of surface learning strategies. It appears that over-emphasis on surface type learning strategies adversely affects quality learning outcomes and academic achievement. Further work needs to be done to explore more fully the relationship and distinctions between surface and deep learning strategies in the discipline of anatomical science.

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