# Active lab-based learning in the biological sciences: First-year Anatomy

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*First-year Anatomy too often involves rote-learning of lists of physical structures, reinforced by weekly viewing of specimens. This approach is adopted due to the volume of material to be learned, and large class sizes. There is little emphasis on critical thinking, self-directed learning, or integration of knowledge. Active learning techniques provide first year students with an introduction to listening, speaking, problem-solving and leadership skills. Although the focus in many first-year courses is on acquisition of knowledge, expectation of the students to integrate and apply that knowledge may lead to greater enjoyment of learning and enhanced functional knowledge. Active learning techniques may be implemented in laboratory classes to extend the first-year Anatomy course beyond rote-learning and recall. This paper outlines the use of strategies including a variety of challenging practical exercises, syndicates, and expansion of the laboratory manual beyond lists and diagrams.*

## Introduction

Gross Anatomy is a year-long course often viewed with trepidation by first-year university students, according to an informal poll of 300 Human Movement students at the University of Western Australia in 2001. The course is divided into laboratory and theory components, with assessment being a 50% exam for each component. The main concern expressed by students was the large volume of work required to be learned, particularly for the laboratory component of the course. When questioned according to strategies employed to learn the material, many students indicated they simply tried to memorise the lists of physical structures appearing in the manual. They also indicated bi-weekly viewing of specimens was awkward and inefficient due to large classes and the relatively unstructured environment in the laboratory.

In courses where a large volume of material is required to be learned, there may be little emphasis on critical thinking, self-directed learning, or integration of knowledge (Barrows & Branda, 1975). Although the focus in many first-year courses is on acquisition of knowledge as a foundation for future learning, expectation of the students to begin to integrate and apply that knowledge may lead to greater enjoyment of learning and enhanced functional knowledge (Walton & Matthews, 1987).

The implementation of active learning techniques in anatomy laboratories may provide a number of benefits to first year students. The outcomes can be divided into three areas:

i. Effects on learning
   - Students will acquire and begin to integrate material
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- Students will be introduced to higher concepts such as evaluation, analysis, and criticism

ii. New skills
The implementation of active learning strategies will provide students with foundation skills in the following areas (Newble & Cannon, 1994):
- Development of a logical, analytical, scientific approach to lab work
- Improvement in critical questioning and reasoning
- Introduction to listening, speaking, problem-solving and leadership skills

iii. Outcomes for students
- Enhanced functional knowledge beyond rote-learning
- Skills and motivation for continued learning
- Enthusiasm for self-discovery
- Improved cooperation and socialisation with colleagues

## Methods

Techniques for active learning may be implemented in laboratory classes to extend the first-year Anatomy course beyond rote-learning and recall. First year students can be introduced to the impact of lifestyle factors and behaviour, risk factors and cause-effect relationships in maturation, disease and injury. This approach aims to not only to maximise retention of information and enjoyment of learning, but also to develop comprehension, application, synthesis and evaluative skills (Branda & Sciarra, 1995; Griffiths & Partington, 1992; Habeshaw, Habeshaw & Gibbs, 1998; Street, 2000).

### *Considerations for implementation of active learning strategies*

With a large volume of work to be learned and class sizes exceeding 50 students, the use of active learning strategies requires organisation, planning and commitment. The following questions should be addressed in the planning of a curriculum (Newble & Cannon, 1994):

*i.* *Understanding:* will the strategies lead to enhanced student comprehension of key concepts?
*ii.* *Time:* how much time is required for planning and implementation? Will the allotted work be completed within the available timeslot?
*iii.* *Organisation:* will the teacher-student ratio permit the activities? Will student involvement be optimal in each activity? Is access available to the necessary resources (equipment and staff)?
*iv.* *Assessment:* how will individual and group work be assessed?
*v.* *Feedback:* will students be given the opportunity to provide feedback about the course structure? How will feedback be given to students during the laboratories?

## The laboratory manual: a useful tool for lab preparation and reinforcement

The laboratory manual is an essential component of student learning as it may be used to complement and facilitate the active learning strategies planned for the lab sessions. The manual usually consists of one section for each of the classes undertaken by the students throughout the year. Each section contains lists of the physical structures (e.g. bones) and their features, accompanied by one or more diagrams. Students use the manual to identify each of the listed items on wet specimens in the lab, with tutors available to verify their

answers. This paper will provide some suggestions for using the lab manual as an effective stimulus for learning, and to support an active-learning based curriculum.

The manual should open with a course description, including the objectives of the unit, and an explanation of the aims, purposes, and organisation of laboratories. First-year students originate from a range of backgrounds and experiences in science, and have different expectations of the laboratories. This section should provide:

i. An informal introduction from the unit coordinator, with emphasis on the lab as an accepting, non-threatening environment in which cooperation is stressed;
ii. Explanation of the roles of teachers and students in the lab and the expectation of active participation by all;
ii. Outline of attendance requirements;
iv. Guidelines for pre-lab preparatory work;
v. Clear description of course assessment.

Each of the lab modules may include a number of key features to facilitate student pre-lab preparation, within-lab learning (and enjoyment!), and post-lab revision:

i. Pre-lab preparation:
To reinforce lecture material and provide the necessary foundation for laboratory work, students may complete a pre-lab section consisting of reading (journal articles, extracts from literature such as Frankenstein), short-answer questions or sketches. Students may be asked to provide a definition, fill in the blanks, label, list, match or name structures.

ii. Main laboratory session:
(see following section)

iii. Post-lab assessable work:
Post-lab work will be designed to reinforce the material learned in the lab, and to encourage students to explore the wider implications. Post-lab work will take the form of questions such as:
*impact of lifestyle factors and behaviour*
*what does this tell us about...*
*what other information might you want*
*what do you think of...*
*what factors contribute to...*
*what would happen if...*
*how do you predict that would work in...*
*explain in your own words*
*give examples*
*differentiate*
*justify*
*how is it similar/different*
*illustrate your answer with a sketch*
*find an article which...*

Where additional information is required, references and other resources will be listed, and made available either in the library or on the web.

## Laboratory organisation

### *Role of the tutor*

In implementing active learning strategies in the lab, tutors and demonstrators have two main roles:

i. facilitate learning by asking non-directive stimulating questions;
ii. provide feedback through summarising, identifying gaps and correcting any misinformation (Barrows & Branda, 1975).

A supportive environment is essential to facilitate successful active learning. Tutors can help to promote such an environment by (Habeshaw, Habeshaw and Gibbs, 1998):

i. breaking the ice immediately
ii. communicating expectations and allowing students to communicate theirs.
iii. establishment of ground rules regarding absence, late work, grading, conduct
iv. making available study aids: library, study tips, study skills centre referrals

Tutor training is highly recommended to maximise the efficiency and effectiveness of the curriculum change. The structure of this training is beyond the scope of this paper, but may include introducing tutors to concepts of problem-based learning (Walton & Matthews, 1987), effective questioning and facilitation of small-group interaction (Branda & Sciarra, 1995).

The role of the tutor will be greatly affected by student-staff ratio. At the time of writing, the course from which students were surveyed had approximately 300 students divided into six lab-groups. Each group was facilitated by two head tutors, with 4 assistant (post-graduate) staff. As many students in the informal poll indicated they felt the tutors were often "too busy to help me", the current student-staff ratio of 1:5 may not be ideal for activities which require an even higher level of interaction.

### *Lab activities*

The traditional lab involves laying out wet specimens on tables, and the students identifying the listed structures from the lab manual in small informal groups, with tutors available to clarify and assist. In a class of 50 or more first-year students, some students may be shy or socially isolated, including those for whom English is not their first language, and those from rural or small schools. Simple strategies can be implemented to ensure that all students are involved, learning, and becoming socialised with each other (Branda & Sciarra, 1995; Habeshaw, Habeshaw and Gibbs, 1998).

A sample one-hour lab is outlined below. The session is divided into three parts, each of which aims to maximise student participation, whilst maintaining a high degree of organisation and order:

*Commencement time: 2pm*

i. Take attendance
ii. Assign students to syndicates by giving them a number (1-10) as they walk through the door.

*Part 1: Introduction: 15 minutes*

i. Post today's "menu" on the board

ii. Large group brainstorm or divide students into small buzz groups. Aim is to elicit student questions and concerns and put them on the board right away
   - *what do we know?* - students recall 5 points from lecture
   - w*hat do we need to know (aims and objectives for the lab)*? - use rounds - 15 seconds per person (can pass) on the topic "a question I'd like answered today…"

   OR …

ii. Present a puzzle or feature, which may be a video, x-ray, chart or audio recording:
   - ask if someone has heard of a similar problem and to tell the group about it.

   Encourage the group to discuss alternative explanations based on their pre-lab preparation and knowledge from the lecture.

*Part 2: Main laboratory session: 35 minutes*
The use of syndicates can be an effective method of sharing information, and developing cooperation and socialisation skills. Students are divided into small groups and the groups assigned the same task. Within the group, students are encouraged to compare notes, explain concepts to other group members, delegate responsibilities and decide on the next action. The outcomes are presented to the whole group at the conclusion of the session (Branda & Sciarra, 1995; Griffiths & Partington, 1992).

*Part 3: Conclusion: 10 minutes*
A variety of strategies can be used to check student understanding at the end of the lab. These may include:

i. Two minutes of individual writing: *5 things I learned today.*
ii. Quizzes: teacher-assigned or put students in pairs and have them quiz each other (3 questions) on today's work. These questions should be based around concepts such as *explain, give examples, summarise in your own words, demonstrate, sketch, compare.*
iii. Rounds (15 sec per person): *What I've got out of today...something I still don't really understand is...What I now intend to find out about/work on is...*

## Discussion

First-year students are the most impressionable and vulnerable in the university environment. In a large, compulsory first-year unit, students vary widely in their prior experiences, learning styles and level of socialisation. Many may not have been previously exposed to independent learning, and hence not make best use of laboratory time where they are expected to complete tasks with relatively little supervision or structure. They may be daunted by the large volume of work required to be learned and resort to rote-learning.

The use of active learning strategies and small-group work has a number of benefits for first-year students, both academically and socially. The use of syndicates (small teams) encourages discussion and interaction. The laboratory manual should also be expanded from mere lists and diagrams. A series of challenging questions and activities for each lab class, requiring students to synthesise the material, develops enhanced functional knowledge. When a logical, analytical, scientific approach is stressed, students are introduced to concepts of criticism, analysis, decision-making, problem-solving, and cooperation. It was not seen as necessary to omit any of the current lab manual content, as the additional material was designed to reinforce, complement and blend with the existing work to provide a platform not only for enhanced retention but synthesis and integration – beyond rote-learning of lists which can be inefficient and ineffective. An additional benefit of the proposed strategies is the development of communication skills in listening, speaking, arguing and group leadership, which are important for later communicating with other professionals (medical, coaching,

community, academics) (Newble & Cannon, 1994). Learning is enhanced as information is both acquired and applied, including prior knowledge from lectures and pre-lab work.

Active learning in laboratories and development of learning habits requires organisation on behalf of tutors and demonstrators. Adequate resources and training must be provided, and clear ground rules established with the students at the commencement of the semester. However, with commitment and enthusiasm, active learning can develop whole-hearted motivation for self-discovery in students, which indeed is the ultimate aim of educators.

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