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MEDICAL STUDENTS PERCEPTION OF PROBLEM TOPICS IN ANATOMY

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ABSTRACT

Objective: To examine the existence of perceived problem topics/concepts in anatomy, possible reasons for the problems and also student suggestions for alleviating the problems.

Design: An open-ended questionnaire.

Setting: School of Anatomical Sciences, University of the Witwatersrand, Johannesburg, South Africa.

Subjects: Two hundred and fifty nine second year medical students.

Main outcome measures: The questionnaire included identification of problem areas, reasons for problems and possible solutions.

Results: The survey revealed a wide range of problem topics, with the majority being experienced in gross anatomy followed by histology and embryology. It was clear that the students experienced difficulties with 3-dimensional conceptualization and the visualisation of structures.

Conclusion: A variety of teaching aids may help in addressing this problem and encourage spatially oriented thinking, leading ultimately to an integrated and in-depth understanding of anatomy.

INTRODUCTION

The process of assimilating and understanding anatomical concepts and relationships is derived by an integration of 3-dimensional (3-D) knowledge. This is a slow process and is built up over time, sometimes only crystalizing after continued study. However, students in professional degrees which utilise a traditional, layered curriculum are generally required to learn and understand anatomy in one year. This usually coincides with the study of physiology and biochemistry, two equally vast and complicated subjects. It is of little wonder, therefore, that some medical students find anatomy and physiology some of the most difficult subjects in their curriculum to understand (Manning, Loening and Saunders, unpublished data).

Certain topics/concepts within the fields of gross anatomy, histology and embryology are believed by teachers of anatomy to pose difficulties for students. While this difficulty is often discussed at congresses and gatherings of anatomists, no specific evidence has been located in the scientific literature. Some of the problems may be due to an inability to visualise 3-dimensional structures. In a subject such as embryology this problem is often compounded when a fourth dimension, time, complicates the understanding of the 3-D changes that are occurring. Information that is not understood or visualised, but is learnt by rote, is usually

not retained. This method of learning is classified as a "surface approach" by Marton(1) and may present major problems, particularly in a layered curriculum. When students proceed into the clinical years they find great difficulty in recalling knowledge that they have learnt by rote. Thus, it is incumbent on lecturers to ensure a comprehensive understanding of anatomy and discourage a surface approach to learning.

A persistent and continuing erosion of the time available for teaching anatomy, together with concomitant loss of academic staff, has become an all too familiar reality(2-7). It is thus even more important for teachers of anatomy to alleviate areas of difficulty for students in the restricted time available. There is a general awareness amongst lecturers that certain topics/concepts in anatomy regularly pose more problems for students than do others (personal communications), yet only limited data are available (8) whereby a meaningful assessment of the problems can be made. The authors believe that it is important, within the constraints outlined above, to establish which areas in anatomy are perceived by students as problematic, and why they are so perceived.

Course Outline: The anatomy course for medical students at the University of the Witwatersrand is currently a "traditional" course placed in the second year of study. Physiology (including biochemistry) is studied in the same year and these two basic science

subjects form part of a layered curriculum. The course in anatomy which is reviewed in this paper includes gross anatomy, histology and embryology. Approximately 350 hours of the 460-hour course are spent on gross anatomy (including embryology), while a further 110 hours are spent on histology. Most of the 460 hours are spent in practical sessions and tutorials (gross anatomy and histology), while lectures are provided in the remaining time. Students undertake regional dissection of the entire human body, which is supplemented with prosected specimens, plastinated specimens, radiographs and scans, and time correlated with the relevant histology (microscopy) practicals, which include exposure to both scanning and transmission electron micrographs. Computer programmes and videos on gross anatomy, histology and embryology and an extensive museum collection supplement students needs. Embryology lectures, videos and a practical are integrated at the relevant points of study. Participative tutorials cover surface and gross anatomy, osteology, histology, embryology as well as problem solving exercises.

The students take four tests during the year and in some cases an end of year examination. The method of assessment follows the method of teaching very closely, so that students undertake testing and examination by means of short questions (some clinically applied), MCQs, practical examinations ("spot" tests) and *viva voces*. Students achieving more than 60% for their year mark are exempt from writing the end of year examination.

The aim of this study was to survey students at the completion of their course in anatomy in order to gain information on what topics/concepts they had perceived to be problematic. In addition, students were requested to provide information on why these topics/concepts were perceived to be problematic and to make suggestions on how the problem/s could be solved.

MATERIALS AND METHODS

The questionnaire was administered to second year medical students at the Faculty of Health Sciences of the University of the Witwatersrand, Johannesburg. The study and questionnaire were approved by the Human Ethics Committee of the University of the Witwatersrand (HEC no: M991013). The questionnaire was designed to elicit responses from the students and not to instill ideas. It was administered at the end of the academic year to ensure that all aspects of gross anatomy, histology and embryology had been dealt with prior to the filling in of the questionnaire.

The students were requested to give information on whether they were taking anatomy for the first time or whether they had completed a prior course in this subject. A student identification number was requested so that responses could be correlated with a level of competence following their end of year examination or exemption in gross anatomy and histology (both topics which include embryology). The questionnaire was divided into three sections, one each for gross anatomy, histology and embryology. The student was

required to identify problem area(s)/topic(s) and give a reason(s) for the area(s)/topic(s) being problematic. They were further asked to suggest a means of solving the problem. Students could list as many problem topics as they wished. Limited guidelines were given by the authors on the questionnaire requesting the students to be specific regarding the identification of problem topics, e.g. autonomic nerve supply to the abdomen, rather than giving a broad area, e.g. the abdomen. The authors also explained this requirement verbally, as well as giving a brief overview of the reasons for the study, prior to administering the questionnaire.

Students were allowed to take the questionnaire with them to allow time for thought. Questionnaires were thus retained by the students for a period of approximately 10 days.

On retrieval of the questionnaires, problem topics identified by the students were grouped by the authors. This was due to the wide range of explanations/terminology used by the students in their replies, e.g. "nerve and arterial supply to the arm", "course of nerves and vessels in the arm" and "innervation of the arm" were grouped as one topic.

In order to calculate which topics/concepts were rated most frequently by students as being problematic, the number of responses to a particular topic was calculated as a percentage of the total number of replies to the questionnaire. Because of the relatively large number of respondents who indicated that they had experienced no particular difficulties with histology and embryology, responses were also calculated as a percentage of the total number of students who had experienced problems in that subject. The list of problem topics, reasons and solutions provided in the Tables is not exhaustive; only those with a response rate higher than 7% have been recorded for ease of display.

RESULTS

A total of 88 out of a class of 259 medical students completed the questionnaire thus giving a response rate of 34%. With the exception of two students, all students who responded to the questionnaire had taken the full anatomy course for the first time. Seventy four (84%) of the students who responded passed the course, while only 14 (16%) failed the course. Of the 74 respondents who passed, 40 (54 %) had received a course mark over 60% and thus were exempt from the end of year examination. Students were not aware of their final mark at the time of completing the questionnaire.

Gross Anatomy; A total of 39 problem topics/areas were identified. Nine of the 88 (10%) respondents believed they had no specific problems with gross anatomy. The remaining 90% of respondents indicated that they had experienced problems with the pelvis (35%), neuro-anatomy (32%), the perineum (27%), the omentum, mesenteries and pleural/pericardial/peritoneal membranes (24%) as well as other less problematic topics (Table 1). A high proportion of the students indicated that the reasons for these problems were failure to form a 3-D picture of the specific area, or that the area was difficult to visualize (87.5%). Thirty three percent of respondents indicated that an area had been difficult to access or had been damaged during

dissection, so that they could not return to it for revision. Further reasons for problems were that the subject was too complicated or difficult to understand (32%) or that there was too great a volume or too much detail required (26%) (Table 1). The students suggested as possible solutions: tutorials utilizing more 3-D-aids such as models, computer programmes, videos and prepared specimens (70.5%), more time for particular topics, dissections and tutorials (33%), more studying on the part of the student with slow and repetitive reinforcement (14%) and also requested that the "important" information be emphasized (10%) (Table 1).

Embryology; Eighteen topics were identified as being problematic, but of these only six had a response rate of higher than 7%. Twenty five out of the 88 (28%) respondents experienced no specific problems in embryology. Thirty five percent of respondents identified the development of the body cavities and mesenteries

as problematic, whereas the urogenital tract (including the development of the external genitalia) (16%), foetal membranes and placentation (11%) and the development of the eye (9%) were identified as other areas of concern (Table 2). Sixty four per cent of the students indicated that these problems stemmed from an inability to visualize, understand or comprehend the sequence of events which characterise these developmental processes, particularly in 3-D (Table 2). Inadequate time and the sequence followed in a lecture(s) (9%), were also given as possible sources of problems. The scheduling of more time and extra tutorials (11%) were suggested as possible solutions (Table 2). The use of more visual aids (videos, computer graphics, slides, and 3-D models) (10%) and changing the format of the lectures by either converting them into small group tutorials and/or including physical specimens to demonstrate structural changes (10%) were also perceived by the students as possible solutions to the problems (Table 2).

Table 1

Students responses regarding gross anatomy

Problem topic/concept [#]	Number of responses	Percentage of responses*	Percentage of responses**
Pelvis	31	35	39
Neuroanatomy	28	32	35
Perineum	24	27	30
Omentum, mesenteries, pleural / pericardial / peritoneal sacs	21	24	26.5
Nerves of upper and lower limbs	9	10	11
Ear	9	10	11
Pterygopalatine fossa / Infratemporal fossa	8	9	10
Muscles of hand and foot	8	9	10
Structure and muscles of tongue / pharynx / larynx	7	8	9
Bones of hand and foot	6	7	7.5
<i>Possible reasons for problems</i>			
Could not visualize in 3-D	77	87.5	97.5
Difficult to access the area / destroy area during dissection / could not return for perusal	29	33	36.5
Complexity of subject matter / could not grasp concept	28	32	35
Too great a volume and detail	23	26	29
Getting used to new terminology	8	9	10
Region not 'taught' / lectured	8	9	10
Insufficient time	7	8	9
Inappropriate placing / did not follow sequence	6	7	7.5
Poor lecture / poor tut	6	7	7.5
<i>Possible solutions for problems[#]</i>			
More visual aids including dissections	62	70.5	78.5
Additional time required/dissection/tutorial	29	33	36.5
Students to study more / slow and repetitive reinforcement	12	14	15
Give basic concepts first/highlight important details	9	10	11
More diagrams and illustrations	7	8	9
Clearer explanations / tutorials / lectures	5	5.5	6

[#]= only problems with a rating of more than 7% are included in the Table

*= number of responses expressed as a percentage of the total number of respondents

**= number of responses expressed as a percentage of those respondents who identified problems

Histology; A total of 22 problem topics were identified but only eight of these were rated as problematic by more than 7% of respondents. One third (28 students) of the respondents believed that they had no specific problems in histology. Sixty of the 88 students indicated difficulties with the subject. The students identified nervous tissue in general (19%), the reproductive system and the placenta (15 %) and smooth muscle (13%) as difficult topics (Table 3). Respondents indicated the following reasons for the

perceived problems: difficult and confusing concepts (21.5%), badly structured lectures (18%) and insufficient time, particularly for practicals (10%) (Table 3). Proposed solutions to the problems were: the scheduling of more lectures to provide additional time to better assimilate the work (13.5%), using more visual aids (photographs, slides, diagrams and 3-D models) (11.5%), restructuring of lectures (9%) and simplifying the information by including summaries or Tables and removing unnecessary details (7%) (Table 3).

Table 2

Students responses regarding embryology

Problem topic/concept [#]	Number of responses	Percentage of responses*	Percentage of responses**
Body cavities and mesenteries	31	35	49
Urogenital tract	14	16	22
Foetal membranes and placentation	10	11	16
Eye	8	9	12.5
Midgut rotation	7	8	11
Pleuroperitoneal membrane and diaphragm	7	8	11
<i>Possible reasons for problems[#]</i>			
Difficult to visualize / orientate, particularly 3-D	56	64	89
Insufficient time	8	9	12.5
Lecture, inadequate / did not follow a logical sequence	8	9	12.5
<i>Possible solutions for problems[#]</i>			
More time / more tutorials / go slower	10	11	16
Use more models and 3-D presentations	9	10	14
Change format of lecture / rather give tutorials	9	10	14

Table 3

Students responses regarding histology

Problem topic/concept [#]	Number of responses	Percentage of responses*	Percentage of responses**
Nervous tissue	17	19	28.5
Reproductive system and placenta	13	15	21.5
Smooth muscle and muscle contraction in general	11	13	18.5
Osteogenesis	10	12	16.5
Collagen synthesis	8	9	13.5
Respiratory system	7	8	11.5
Process of keratinisation	6	7	10
Oral tissues (not tooth)	6	7	10
<i>Possible reasons for problems[#]</i>			
Difficult, confusing concepts	19	21.5	31.5
Lecture not well structured	16	18	26.5
Insufficient time-lectures and practicals	9	10	15
Difficult to identify structures on slides	7	8	11.5
Complex /confusing structure / cannot recognise difference between structures	6	7	10
<i>Possible solutions for problems[#]</i>			
More time/more lectures	12	13.5	20
Use more visual aids including models, particularly 3-D	10	11.5	16.5
Restructure lecture	8	9	13.5
Simplify the information/give less details/make differences clear	6	7	10

DISCUSSION

The poor response of medical students to the questionnaire (34%) is of concern and in contrast to that of other medical students, veterinary students and graduates who have participated in surveys by questionnaire [eg. 70.5% (8); 88.7% (4); 97% (Manning *et al*, unpublished data); 74% (medical graduates) (9)]. In only the report by Manning *et al*, did the students constitute a "captive" audience. As adequate time was given for our students to fill in their responses and constant reminders to return the questionnaires were made, one can only assume that the motivation of this group of medical students to assist in a study of this kind was low. It is acknowledged that the low response rate may obviously affect the findings of the survey, but if teachers of anatomy are serious about improving the learning environment for students, then the responses in general demand analysis. A higher return of questionnaires was received from "good" students (57%; mark of 60 % or higher) than from "poor" students (43%; mark of 59% and lower) based on the comparison of responses with final results obtained. While we believe that the response to the questionnaire was low, the replies confirmed those areas of anatomy which are perceived to be problematic for students in our experience.

Problem topics were identified in all three areas of anatomy, although more were listed in gross anatomy (39 students) than in histology (22 students) and embryology (18 students). Although a variety of problem topics were noted by the respondents, it is difficult to discuss each item individually. The most urgent consideration which arises from the results of this survey is the difficulty that students apparently experience with 3-D concepts and visualization of structures. The same reason for problems in anatomy was identified by local veterinary students (8). Medical students responses as to why they believed they had experienced problems with the identified topics in all aspects of anatomy were dominated by a perception that they could not visualise 3-D structures and could not orientate themselves on the material being studied. They also found the material too complex and needed more time to study and understand the information. In gross anatomy, the topics most frequently identified as problematic (pelvis, neuroanatomy, perineum and omentum and linings of the body cavities) are known to be demanding and pose difficulties for students in terms of visualization and understanding. This phenomenon may also be due to the complicated nature of, and restricted access to, certain regions (e.g. the pelvis), an inability to conceptualize the area being studied (e.g. the reflections and recesses of the linings of the body cavities) or a combination of both. It is interesting that this problem persists in the gross anatomy course despite different approaches to the dissection of the pelvis and perineum being attempted

in order to display this area in the best possible way for the students. The difficulty experienced in gross anatomy with body cavities is echoed in the responses to problems in embryology with the intra-embryonic coelom being identified as problematic. This is certainly one of the most difficult topics for students to grasp and understand.

While our students do not suggest problems with 3-D concepts in histology, they may be unaware that a problem actually exists. During *viva voce* examinations, when they are requested to draw what they are explaining, they are often not able to do so. This inability by students to reconstruct or visualize 3-D representations from 2-D preparations (histology slides) may indicate inadequate guidance from teaching staff regarding how to conceptualize 3-D structure. In general, medical students appeared to experience more problems with histology than did veterinary students in a comparable course (8). However, veterinary students display a strong perception that the correct use of a microscope is an essential skill for the practice of veterinary medicine(8,10) which may influence their attitude to the study of histology.

Students of anatomy should possibly be taught to rely more on mental imagery in order to integrate their knowledge of anatomy. Imagery may involve any of the senses, but the form of imagery commonly reported by laypersons and most commonly studied by cognitive psychologists is visual imagery(11)." Studies suggest that there are two systems of imagery, one involving non-spatial visual abilities (colour, shape) and the other involving spatial attributes (location, orientation, size or distance scaling). Spatial information is said to be processed on one side of the brain and symbolic information in the opposite hemisphere(11). Perhaps teachers of anatomy should introduce the topic of visual imagery and also, "guided fantasy" (12) to their students early in the course in order to attempt to emphasize the importance of this mode of studying anatomy. Guided fantasy introduces the student to the possibility of educating the "right"-brain i.e. to spatial-oriented, whole pattern perception and the ability to "think in pictures".

Neuroanatomy was identified as a particular area of difficulty and is also perceived to be problematic by South African veterinary students (8). Neuro anatomy has previously been quoted by dental students as the most difficult of the four anatomy topics (topographical anatomy, histology/cell biology, neuroanatomy and embryology) presented(13). de Lahunta(14) has cautioned that isolated exposure to neuro-anatomy unrelated to clinical neurological signs is a problem in veterinary medicine. A system of self-instructional laboratory stations was found to be time effective and enthusiastically received by the students in combating students' problems with neuro-anatomy(15). Our students receive a course (lectures, tutorials, dissection and histology) in neuro- anatomy which is time-correlated

with a neurophysiology course. The students are not, at this stage of study, formally exposed to hands-on clinical neurology. The perceived problem in neuro-anatomy is thus difficult to explain, other than that it is an exceptionally difficult area of anatomy that requires a lot of thought and understanding and the time in which to do so. Correlation with clinical neurology may stimulate interest and improve the understanding of this topic. In addition, any anatomy taught in the context of "real patients" may foster better understanding and retention.

It was evident in our study from the responses to suggestions for improving a problem, that students want more time, more lectures, more tutorials, more models, more visual aids. While some of these requests are valid, there is a concern amongst faculty that students are becoming increasingly dependent on them. This is a major problem, as the number of academic staff available to assist students has been reduced. For this reason, additional tutorials as requested by the students in their responses to the questionnaire, are difficult to implement. Conversely, as our ultimate aim should be to train students as independent thinkers and life-long learners, we should be attempting to free them from their dependence on their teachers. The facilities in the Department are above average; sufficient cadavers are available, laboratories remain open for 8.5 hours a day from February until November. Students should be making more use of these facilities, without the need for an accompanying member of staff.

There is a belief that the current mode of instruction in many of the secondary schools in South Africa does not prepare students adequately to be able to work, analyse and understand for themselves, and most certainly does not prepare them for entry into a tertiary institution. The school situation places students in a position where a large number become rote learners. Parkin and Rutherford(13) report a similar request for increased assistance with learning from dental students in a first year anatomy course and relate this to substantial differences in the way in which teaching and learning are practiced at school and at university.

While the request for more is a concern to lecturers, final year undergraduate students when questioned on their gross anatomy curriculum which they had experienced five years previously, also asked for more(16). They requested more clinically oriented topics, more presentations on patients, more living (surface) anatomy and more cross-sectional anatomy as a basis for CT, MIU and ultrasound emanating from their experience in the clinical years. While students request more time to assimilate and explore different areas of anatomy, Faculty curriculum committees continue to erode time in the basic sciences. From a student perspective this would appear to be a deleterious decision.

It was also clear from this survey that reasons for problems with a particular topic were attributed to

lectures in only a small percentage of cases. This was supported in a study carried out on veterinary students(8) in which only 4.5 % of respondents claimed to have a problem with lectures. Medical students suggested having tutorials rather than lectures in embryology (10%) and the structure of a lecture was criticised in histology (18%). In the latter case the remarks referred mainly to a single lecture in which the histology and embryology had been linked in what appeared to the students to be a haphazard fashion. Cawunder and Tasker(17) have previously noted from their assessment of veterinary students that most "learning" in anatomy takes place in a laboratory. It is perhaps for this reason that students do not depend or find major fault with lectures. Students are able to review their anatomy in practical sessions irrespective of the quality of the lecture.

In conclusion, this study identifies a range of problem topics/concepts in anatomy experienced by undergraduate medical students in a traditional curriculum. Most of the responses to the questionnaire indicate a deficiency in understanding due to problems with visualization and conceptualization. While innovative teaching methods, advanced audio-visual technologies and changes to curricula are the order of the day, only by identifying the areas of difficulty in anatomical concepts can suitable strategies be devised for the resolution of these problems. It is yet to be shown whether-problem based curricula alleviate the perceived problems in the understanding of anatomy.

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