

## Medical physiology education in South Africa: what are the educators' perspectives?

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*Context.* Most South African medical schools have, in the past decade, introduced changes in their curricula. In our experience we have found that such changes can affect students' knowledge and understanding of physiology.

*Aim.* The current study was undertaken to determine the perceptions of educators regarding the impact of curricular change on the knowledge and understanding of physiology by medical students in South Africa.

*Methods.* A survey of physiologists teaching medical students in South African medical schools was undertaken by means of a questionnaire.

*Results.* There were 20 participants in the current study. Demographic data revealed that they came from 6 out of the 8 South African medical schools; 80% had PhDs; 70% had been teaching physiology for more than 10 years and that a similar percentage (80%) were experienced in teaching three or more physiological systems. In addition, 20% of the current participants had additional educational qualifications. In the opinion of the physiologist educators surveyed, 60% felt that although current medical students found it more difficult to understand basic

physiology concepts and that, compared with students 5 - 10 years ago, their knowledge of physiology was more limited, the students nevertheless were better able to integrate their physiology knowledge with clinical subject knowledge. The respondents were divided as to whether or not current medical students found it more difficult to understand pathophysiology than those students 5 - 10 years ago. In addition, nearly 60% of the staff surveyed were concerned that physiology, as a cognate discipline in South Africa, was under threat due to medical curricular change.

*Discussion and conclusion.* The results of the survey provide a snapshot of the current state of medical students' knowledge and understanding of physiology in South Africa from the educators' perspective. It would be interesting to know whether the concerns raised by the participants reflect an international trend. Physiologists and curriculum planners/organisers need to take cognizance of the issues highlighted in the current study.

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### Introduction

In 2001 the traditional 6-year medical curriculum at the Nelson R Mandela School of Medicine (NRMSM), University of KwaZulu-Natal, was phased out and replaced with a new 5-year problem-based learning (PBL) curriculum. Despite being implemented in different ways,<sup>1,2</sup> PBL has a number of common characteristics, including facilitated small-group learning, active learning stimulated through using cases or problems, framework lectures with minimal expert inputs, and themes which emphasise an integrated and multidisciplinary approach.<sup>3</sup> From 2006 there have been several modifications of the PBL curriculum at NRMSM, which have included a reduction in the PBL approach in fourth year to enable more clinical bedside teaching, and the introduction of a basic science module at the beginning of first year. These curricular modifications were introduced to address the concerns expressed by clinicians, basic science teachers, the Health Professions Council of South Africa and medical students themselves. Various aspects of the PBL curriculum at NRMSM have been documented previously<sup>4-6</sup> and more recently by ourselves.<sup>7</sup>

Initially the PBL at NRMSM was delivered over the first 4 years of study with the 5th year retained for clinical teaching. It became increasingly evident to the authors, in our dual roles as both PBL facilitators and expert teachers on this programme, that there were apparent gaps in students' knowledge of physiology, a perception that was shared by our clinical colleagues. A subsequent survey was conducted by us in which NRMSM students were asked to what extent they thought physiology was essential for their understanding of pathology, interpretation of patients' clinical signs and presenting symptoms, and analysis of laboratory results. The questionnaire also probed the difficulties that students experienced in understanding large group resource sessions (LGRS) on clinical and physiological topics. The majority of the students surveyed indicated that greater interaction with experts was needed since they were experiencing difficulties both in terminology and in grasping essential physiology concepts. Interestingly, Abu-Hijleh and co-workers, in their study of the effectiveness of a PBL module on the cardiovascular system, also found a substantial majority of their students (90%) identified shortcomings in their knowledge pertaining to the physiology of this system.<sup>8</sup> In our study of student perceptions,

the students also highlighted the need for an understanding of physics (electrocardiogram interpretation), chemistry (acid-base balance), biochemistry (gastrointestinal tract physiology) and an ability to integrate knowledge, as required for an understanding of renal physiology, for example.<sup>7</sup>

Physiology is well known to be a discipline that presents most students with a challenge. A number of papers have highlighted this fact from the view of both students and staff alike.<sup>7,9-12</sup> In 2007 Michael<sup>13</sup> reported on a survey which was conducted on faculty members into the factors that were required for the learning of physiology and those that make physiology difficult to learn. A number of key issues were identified: need for an understanding of physics and chemistry, and physiological phenomena at different organisational levels simultaneously; a failure of students to appreciate the integrative nature of physiological mechanisms; and the tendency for students to compartmentalise information. As teachers of physiology, we can fully relate to these findings and the observations made previously by Somjen.<sup>9</sup>

Most South African medical schools have recently undertaken curricula changes similar to those at NRMSM.<sup>14</sup> In the light of our findings and experiences, and that of others, we were prompted to undertake the current study. The focus thereof was the impact that curricular changes may have had on the teaching of physiology, and students' understanding and knowledge of physiological concepts. This paper thus details the results obtained from a questionnaire survey of a sample of South African medical physiology educators.

## Method

The survey was conducted at the 2009 Conference of the Physiological Society of Southern Africa (PSSA) and includes data from 20 academics, most of whom attended the conference. The inclusion criteria for participation included permanent, full-time teachers of physiology to medical students at the time of the survey. Physiologists who do not teach medical students or those who only teach related subjects, such as histology and biochemistry, were excluded from the study. Ethical approval (W301/05) for the study was obtained from the Biomedical Research Ethics Committee, University of KwaZulu-Natal. Informed consent was obtained from each participant prior to administration of the questionnaire, a copy of which is included in Table 1 (overleaf).

The 2-page questionnaire was made up of 4 themes and comprised questions with simple Yes/No options, 4-point Likert scale ratings (1=strongly agree and 4=strongly disagree) as well as a number of open-ended questions. The first theme was concerned with obtaining relevant bibliographic data from the respondents; the second theme explored the specific areas he/she taught and the textbooks used. The perception of physiology teachers on the ability of current medical students to understand basic concepts were probed in theme 3 as well as a comparison with the abilities of those students studying 5 - 10 years ago. Information regarding the way that physiology was incorporated into the medical curriculum at their Institution, the way it was taught, the perceived challenges of teaching physiology and the possible threat that curricular changes may have on physiology as a cognate discipline, made up theme 4.

## Results

The results of the study are presented in Tables 2 - 4 and Figs 1 - 3.

### Theme 1: Demographic data of participants

The 20 medical physiology educators who were included in the survey came from 6 of the 8 medical schools in South Africa (Table 2). The 6 medical schools represented by the participants were equally split between historically white universities (predominantly academically advantaged students) and black universities (predominantly academically disadvantaged students). The highest qualification of the majority of the respondents (80%) was a PhD, with 25% (4/16) of these also being medically qualified. In addition, 20% (4/20) of the current participants had additional educational qualifications. In terms of years of teaching experience, 45% (9/20) of those surveyed had greater than 15 years of experience, whereas only 1 (5%) participant had been teaching for less than 5 years.

### Theme 2: Areas taught and textbooks prescribed/recommended

Fig. 1 depicts that 70% of those who participated in the current survey were experienced in teaching three or more physiological systems. The six participants, who reported teaching only two of the 10 major physiology systems/topics (as listed in Table 3), were from four different institutions, had between them four PhDs and two Masters degree qualifications and only one had less than five years physiology teaching experience. Similarly, the three physiology educators who reported teaching all 10 topics had between them 2 PhDs and 1 Masters degree qualifications, teaching

**Table 2. Profile of the participants (n=20) in the survey conducted**

Institutions (number of participants)	Rank*	PhD	MB ChB	Teaching qualification	Years of experience			
					>5	5 - 10	10 - 15	>15
University of Cape Town (1)	1SL	1	1	0		1		
University of KwaZulu-Natal** (2)	1AP; 1P	2	0	1				2
University of Limpopo (MEDUNSA)** (3)	2L; 1SL	1	0	1		1	1	1
University of Stellenbosch (3)	2SL; 1P	3	2	0		1	1	1
University of the Witwatersrand (7)	1L; 1SL; 3AP; 2P	7	1	0		2	3	2
Walter Sisulu University for Technology & Science** (4)	1L; 2SL; 1AP	2	0	2	1			3
Overall (20)	4L; 7SL; 5AP; 4P	16	4	4	1	5	5	9

\*L = Lecturer; SL = Senior Lecturer; AP = Associate Professor; P = Professor. The ranks given above are those as reported in September 2009.

\*\*Represents universities that were traditionally reserved for non-white students, i.e. academically underprepared students.

**Table 1.** Questionnaire used in the current study

**QUESTIONNAIRE**

***Physiology Teaching and Medical Curriculum Change in South Africa***

We are currently conducting research of medical curricular changes in South Africa, with a particular emphasis on how these curricular changes have impacted on students' basic understanding and knowledge of physiological concepts. We would like to extend an invitation for you to participate in this survey, the results of which will be published and presented at relevant conferences. Your completion and return of this survey will imply your consent to participate in the study. Please be assured that your name will be kept strictly confidential. Should you, for any reason, decide at a later stage that you do not wish the information we have obtained from you be used in any way, you will of course be free to contact us and we will disregard your inclusion in the survey.

Your participation in this survey is greatly appreciated.  
 Mark Tufts and Sue Higgins-Opitz, School of Medical Sciences, University of KwaZulu-Natal

1. I am currently employed at ..... (Institution)

2. My highest qualification is \_\_\_\_\_(please tick as appropriate)

B.Sc. (Hons)                       M.Sc                       Ph.D                       MBChB

Other .....                      Please specify.....

3. I have a formal postgraduate qualification in education Yes / No

**If yes, please specify** .....

4. My current academic rank is .....

5. My total teaching experience at a tertiary level is    < 5 years,                      5-10 years,                      10-15 years,                      > 15 years  
 (please circle as appropriate)

6. Briefly list the areas of Physiology you have taught to medical students:  
 .....  
 .....

7. Which physiology textbooks do your medical students use? Indicate whether these are **prescribed (P)** or **recommended (R)**.

**List** .....

8. Explain how physiology is taught to medical students in your faculty:  
**Explain**.....  
 .....

**For the following questions, please circle answers as appropriate where 1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree.**

9. In my opinion, the overall knowledge of physiology of our current medical students is more limited than students who graduated 5 to 10 years ago 1 2 3 4

10. I am concerned that physiology as a cognate discipline is under threat as a result of medical curricula change 1 2 3 4

i)                      in South Africa 1 2 3 4  
 ii)                      at my Institution 1 2 3 4

11. In my opinion, our current medical students are better able to integrate physiology with clinical subjects than students 5 to 10 years ago 1 2 3 4

12. In my opinion, our current medical students have difficulty understanding basic physiology concepts 1 2 3 4

13. In my opinion, our current medical students have more difficulty understanding pathophysiology than students 5 to 10 years ago 1 2 3 4

14. From your experience, list the strengths and weaknesses of the teaching of physiology to medical students at your Institution?  
 .....  
 .....

15. Please indicate your preferred ways for us to clarify information you have given us for follow-up purposes

(Please tick as appropriate)

Telephonically                       eMail                       Personal Appointment

Contact Details:  .....  .....

**Thank you so much for taking the time to complete this questionnaire**

**Mark Tufts & Sue Higgins-Opitz**

experience ranging from five to more than 15 years, and were also from different institutions. Table 3 also gives the numbers and percentages of the participants who reported teaching each of the major physiology systems/topics.

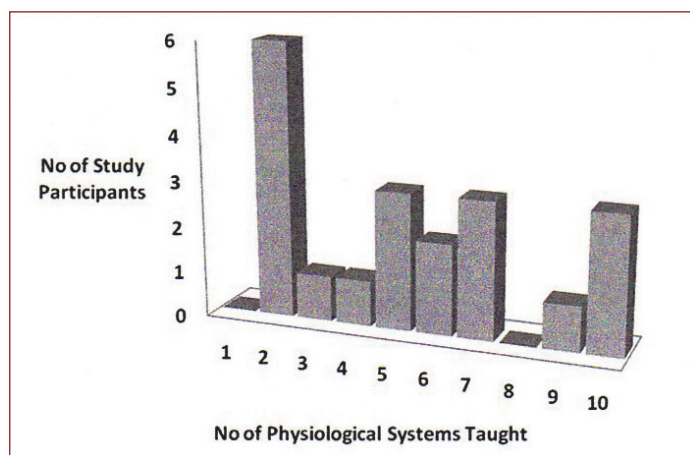


Fig. 1. Graphic representation of the numbers of physiology systems/topics taught by the study participants.

**Table 3. Overview of the major physiology systems/topics taught by the study participants**

Physiology systems/topics	Study participants, n (%)
Neurophysiology	13 (65)
Cardiovascular physiology	13 (65)
Endocrine physiology	60 (12)
Renal physiology	12 (60)
Respiratory physiology	11 (55)
Gastrointestinal physiology	9 (45)
Acid-base physiology	9 (45)
Reproductive physiology	9 (45)
Nerve and muscle physiology	9 (45)
Blood and immune system physiology	8 (40)

The most common texts cited by the participants were books authored by Ganong (8 times), Guyton (8 times), Sherwood (9 times) and Silverthorn (6 times). Physiology teachers at all the institutions represented in the study, with the exception of one, cited both Ganong and Guyton either as a prescribed or recommended textbook. The use of Sherwood and Silverthorn was limited to either 2 or 3 institutions, respectively. As shown in Fig. 2, the majority of respondents in this study cited 2 or more texts.

### Theme 3: Comparison between current and past medical students as perceived by participating physiology teachers

In the opinion of the physiologists surveyed, approximately 60% felt that current medical students, compared with students who trained 5 - 10 years ago, found it more difficult to understand basic physiology concepts and that their knowledge of physiology was more limited (Survey Questions 12 and 9, respectively; Fig. 3). Interestingly, a similar proportion reported that the current medical students were better able to integrate physiology with clinical

subjects (Question 11). The respondents were divided as to whether or not current medical students find it more difficult to understand pathophysiology than students who trained 5 - 10 years ago (Question 13; Fig. 3).

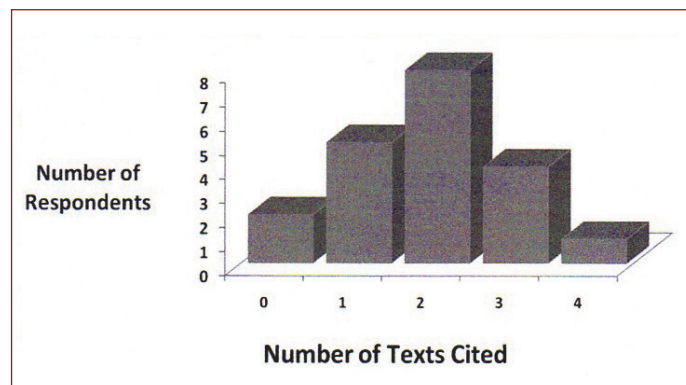


Fig. 2. The number of physiology textbooks recommended or prescribed by medical physiology teachers participating in this study.

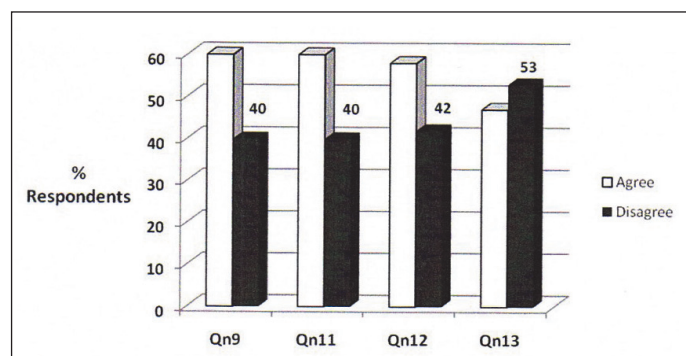


Fig. 3. Percentage of respondents who agreed and disagreed with the statements posed in survey questions 9, 11, 12 and 13, respectively.

### Theme 4: Physiology teaching at the Institutions of the survey participants

Details of the medical curricula and the way in which physiology is incorporated and taught in the institutions of participating physiology teachers are summarized in Table 4. The perceived strengths and weaknesses of the teaching of physiology to medical students at these institutions are also enumerated (Survey questions 8 and 14). Finally, while most thought that physiology was not under threat at their own institutions, nearly 60% of the staff surveyed were concerned that physiology, as a cognate discipline in South Africa, is under threat due to medical curricular change (Question 10 of the questionnaire).

## Discussion

Despite the fact that only 20 physiologists participated in the current survey, the results provide us with a snapshot of the current state of medical students' knowledge and understanding of physiology in South Africa from the perspective of their educators. As a group, it should be noted that they represent the voice of well-qualified (80% PhD) and experienced medical physiology educators; 70% of the respondents had more than 10 years of physiology teaching experience and taught a median of five physiological systems (range 2 - 10).

**Table 4. Perceptions of physiology teaching staff regarding the teaching of physiology to medical students at their institutions**

Institution	Length and structure of medical curriculum*	Mode of physiology teaching	Perceived strengths	Perceived weaknesses
University of Limpopo MEDUNSA campus	6-year programme	Traditional lecture-based course with practicals and tutorials taught in the second year of study	Use of active teaching and learning strategies such as group work	Large classes; resource and staff constraints; background of students (perceive PBL to be a way forward)
Stellenbosch University	6-year programme  Three phases: phase I – Foundation (12 months); phase II – Clinical medicine (42 months); phase III – Clinical consolidation (18 months)	Didactic teaching in an integrated systems-based curriculum taught primarily in phase II	Theoretically physiology is better integrated	The different systems are not sufficiently integrated resulting in physiology knowledge that lacks coherence and is fragmented
University of Cape Town	6-year programme  Year 1 – Foundation courses (12 months); year 2 and 3 – Integrated health care systems, including physiology (24 months); years 4 - 6 – Clinical disciplines	Based on a PBL programme with supplementary lectures and practicals; physiology is integrated with other subjects, mainly anatomy.	Physiology learning is integrated with that of other subjects	Lack of emphasis and depth of physiology concepts
University of the Witwatersrand	<b>School leavers' programme (6 years)</b>  Year 1 – Foundation courses (12 months). Lecture-based medical science and humanities courses (12 months)  Years 3 and 4– Integrated health care systems, including physiology (24 months)  Years 5 and 6 – Clinical disciplines (24 months)  <b>Graduate entry medical programme (GEMP) (4 years)</b>  Same as years 3 to 6 of the school leavers' programme	In the second year it is lecture, practical and tutorial-based; students are expected to be able to apply their knowledge to clinical problems  In the third and fourth years, it is integrated as part of various learning topics covered in the medical curriculum	Integration of physiology with anatomy and biochemistry in second year; use of tutorials (small group teaching) in 2nd year to integrate knowledge gained in lectures; strong emphasis on application	Loss of the 3rd year pathophysiology course due to implementation of the GEMP; problems associated with physiology teaching and learning in the GEMP are isolated lectures; poor integration; and some inadequately prepared students; the introduction of the GEMP has placed additional burdens on 2nd year students viz. modules they now have to complete
Walter Sisulu University	5 year (60 months); 3 phases with 4 themes in each phase  A 6-year programme, in which phase III has been extended, was introduced in 2010	PBL programme with lectures where necessary; systems-based in phase I and clinical disciplines in phases II & III	Knowledge that students have of physiology is integrated with other learning	In-depth knowledge of physiology seems to be lacking

**Table 4. Continued**

University of KwaZulu-Natal	5 years (60 months) Years 1 - 3 – PBL Year 4 – predominantly clinical with some PBL Year 5 – clinical rotations (A 6-year programme was introduced in 2010 in which phase III was extended)	Year 1 – 6 weeks of lectures on an introduction to basic sciences Remainder of Year 1 and Years 2-3 physiology material integrated into cases according to themes of approximate 6 weeks duration, with occasional didactic lectures	In theory the PBL concept is sound	Lack of physiology practicals emphasising basic physiological concepts. This means that students are required to apply basic physiological concepts to complex pathophysiological phenomena without having first mastered basic physiology knowledge
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\*Additional details obtained from respective websites.

The findings of the current survey corroborate an earlier study on what medical students at NRMSM perceived the challenges of learning physiology in a PBL curriculum to be.<sup>7</sup> The students surveyed strongly felt that the basic conceptual foundations that are required for the understanding of physiological concepts were lacking. It is thus noteworthy that these sentiments are mirrored in the responses of the physiology educators surveyed in the current study regarding students' knowledge and understanding of basic physiology concepts. It is encouraging to note that despite this, medical students of today (as reported by a majority of the physiology educators surveyed) still appear to be able to integrate their physiology knowledge with clinical subjects. One possibility is that students are able to integrate the physiology knowledge they possess into clinical scenarios. It is worth noting that the responses of medically qualified physiology educators regarding integration with clinical subjects were divided equally.

An analysis of the educators' perceived strengths and weaknesses of physiology teaching at their respective institutions identified a common theme. Whilst integration was recognised as a strength, the educators as a whole were concerned that the fragmentation of physiology learning inherent in the PBL approach was resulting in a lack of depth and understanding of physiology by their medical students, particularly in terms of the basic concepts underpinning the learning of physiology. It would seem that students are expected to apply their knowledge before mastering the basics. There is thus a need to interrogate these perceptions further through more in depth analyses such as follow-up interviews with both medical physiology educators and teachers of clinical medicine.

A review of the available literature revealed that there is a dearth of studies that deal with the perceptions of staff relative to that of students concerning physiology teaching and learning. Papers dealing with staff perceptions fall into three broad categories: the opinions of staff within the same Faculty,<sup>15</sup> the opinions of various faculty staff members within a country,<sup>16-18</sup> and feedback from faculty staff across the globe.<sup>9,13,19,20</sup> In only one of all these surveys<sup>9</sup> was South Africa represented, albeit by less than 2% (2/116) of the responses received. The course content, in terms of the range of topics and textbooks used comprised part of these surveys. As was the case in the current study, the textbooks of choice in medical courses globally were Ganong and Guyton, while similar physiological topics were taught.

Sefton<sup>20</sup> in the 2005 Claude Bernard Distinguished lecture, drawing on her experiences of running national and international physiology teaching workshops, set out and discussed the various contexts and challenges facing physiology teachers worldwide. Some of these included the avoidance of unnecessary duplication, agreement on consistent terminology, defining what is to be learnt and to what depth, the use of on-line resources and the flexibility thereof. These sentiments were endorsed by Lau in 2004, when he stated in the case of teaching pharmacology in a PBL setting that 'the major problem perhaps is not whether PBL is effective for the teaching of pharmacology, but rather whether learning of pharmacology is effectively integrated into PBL'.<sup>19</sup>

Although a substantial number of physiology staff participating in the current survey felt that physiology as a cognate discipline was being affected detrimentally by the various medical curricular changes that have taken place in the past decade, this perception was not uniform across all the institutions surveyed. Educators at one institution all agreed that in South Africa physiology was under threat whilst in two institutions there was a 50:50 split. None of the physiology educators in the remaining three institutions agreed. This difference could not be attributed to whether the institutions were formerly disadvantaged or not.

There are a number of limitations to the current study. Firstly, only approximately 40% of the total number of full-time physiology educators in South Africa who teach medical students participated in the survey. Secondly, two of the medical schools, the University of Pretoria and the University of the Free State, were not represented. Thirdly, there were instances where staff at the same institution differed substantially in their perceptions, making interpretation of some of their responses difficult. However, every attempt was made to verify the factual information given by staff, including visiting the websites of the respective medical schools.

## Conclusion

The survey reported on here serves to highlight the challenges faced by both physiology educators and curriculum designers, particularly in the case of PBL curricula. Educators need to ensure that medical students gain both the scope and depth of physiology knowledge and understanding that

they need without losing their ability to integrate this knowledge within clinical disciplines. This may entail physiologists adopting a more active and participatory style of teaching and learning.<sup>20</sup> On the other hand, medical curriculum designers and organisers need to be sensitive to the perceptions of experienced and well-qualified physiologists, and ensure that the exposure of students to physiology, and indeed all other basic sciences in the curriculum, is adequate. The importance of physiology to medical studies should not be underestimated since, as has been previously reported,<sup>7</sup> the way it is taught does have an impact on student learning. This paper makes a strong case for improved communication between curriculum designers and basic scientists teaching students in the early years of undergraduate medical programmes. Both parties have valid concerns and all need to be addressed in mutually beneficial ways such that student learning is enhanced.

**Conflicts of interests.** None.

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