THE IMPACT OF THERAPEUTICS TUTORIALS ON THE REASONING OF FOURTH YEAR MEDICAL STUDENTS WITH REGARD TO THE PRESCRIBING PROCESS

by

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DEDICATION

To my husband,

Stuart

and my sons,

William and Benjamin

DECLARATION

This study represents original work by the author and has not been submitted to any other university. Where use was made of the work of others it has been duly acknowledged.

Catherine Sara Harries

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The research described in this thesis was carried out under the supervision of Charlotte Mbali and Julia Botha of the University of KwaZulu Natal

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PREFACE

This research was initiated as a response to a request for assistance from a group of students at the Nelson R Mandela School of Medicine who had reported feeling unprepared to prescribe medicines. This led to an interest in the level of competence shown by students in making prescribing decisions and the extent to which they were confident of their prescribing judgments.

Student prescribing competence and confidence were assessed using quantitative and qualitative methods. The quantitative assessment comprised a test where students were asked to rate their confidence in some of their responses. A stratified sample of 10 of these student interviewed, where they were asked to choose treatment for four paper cases. Prescribing skills were found to be lacking, with test results averaging 47%. appropriate treatment selected for only 4 of the total of 40 paper cases. Upon reviewing the literature, it became apparent that poor prescribing skills, leading to the problem of irrational prescribing was a worldwide phenomenon The study aimed to address areas of weak prescribing skill using a short intense intervention comprising of several different learning strategies. Student change in confidence following the course was assessed using an evaluation form where students rated their perceived changes in key competences. Students showed improved confidence for each of the prescribing abilities measured.

These findings have been compiled into 3 research publications, the texts of which are bound together as they were submitted together to comply with the research requirement of an M.Ed. The findings are reported in a paper titled *Building successful therapeutics into a problem-based medical curriculum in Africa* in the South African Journal of Higher Education (see Appendices).

I was also interested in how prescribing ability builds as students develop new prescribing skills. The student interviews provided an opportunity to explore the variation shown between

the students relating to the quality of the treatment they prescribed for a given paper case. A sample of two sets of paper cases were assessed using a phenomenographic method, yielding two different perspectives of student experience.

The research outlined above is the focus of the dissertation, which also includes an exploration of the teaching and learning issues which guided the design of the intervention and which I believe led to the positive finding of improved student prescribing confidence.

Also included in the dissertation is an analysis of the quantitative assessment according to the cognitive categories of Bloom's Taxonomy, as well as qualitative data gathered from student interviews which revealed an understanding about prescribing abilities which predominated at differing Bloom cognitive levels for different students.

In the second paper titled *Undergraduate medical students' reasoning with regard to the prescribing process* which has been submitted to Medical Teacher, (see Appendices) the range of student cognition associated with prescribing is explored. Each question from the quantitative assessment of prescribing abilities were grouped according to the Bloom Category it had been assigned, student scores according to each Bloom category were calculated. Students scored highest for the lowest cognitive category ('knowledge') and lowest for the highest ranked cognitive categories('evaluation' and 'synthesis'). These findings along with the qualitative findings and the phenomenographic assessment were reported here.

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ABSTRACT

Irrational prescribing may originate in undergraduate therapeutics education, where prescribing skills are often overlooked. The World Health Organisation has developed a rational prescribing approach. In 2004, the first cohort of Problem Based Learning IVth year students at Nelson R. Mandela School of Medicine, Durban, South Africa requested help as they felt unprepared to prescribe medicines. We aimed to assist students in improving their prescribing competence and confidence. Students were tested and asked to rate their confidence for some of their responses. A stratified sample of 10 of these students was interviewed, and they were asked to prescribe treatment for 4 paper cases. Analysis of transcripts included a phenomenographic component to investigate variation in students' ways of experiencing prescribing. A week-long intervention was designed, employing several learning strategies to cover key prescribing skills and areas of weakness. Students evaluated the course, rating changes in key competences. Test results averaged 47%. True/false questions were better answered (69%) than short answer questions (21%). For the true/false and short answers respectively, the worst answered questions were those testing drug level interpretation (48%) and dosage calculation (5%). During student interviews, appropriate treatment was given for 4 of 40 cases and important patient information in only one case while eight students gave an appropriate information source. The phenomenographic analysis yielded outcome spaces which revealed 2 different perspectives of student experience. The course evaluation was positive with students indicating improved confidence in all prescribing abilities. Several course strengths highlighted by students matched qualities recognized to foster good learning.

Chapter 1 INTRODUCTION

In 2004, the first cohort of Fourth Year students following the new PBL curriculum (started in 2001, and in IVth year in 2004) reported feeling unprepared to prescribe medicines. They requested further contact sessions to improve their prescribing competence and confidence. They were not able to say which specific topics or skills needed attention, but they reported enjoying paper prescribing problems where a treatment decision had been reached by following steps based on the P-treatment plan, a rational prescribing approach developed by the World Health Organisation (described in more detail in Chapter 2). My aim was to design a short intervention to address the students' concerns.

Following a worldwide trend, undergraduate teaching at the Nelson R Mandela School of Medicine adopted a problem-based curriculum in 2001. However, the majority of problems used throughout this curriculum focus on diagnosis, leaving students little incentive to select the most appropriate treatment from a variety of options.

In addition to the tutorials focussing on the medical problem in question, learning opportunities such as large group resource sessions (LGRS), practicals and clinic visits were scheduled to supplement the students' learning. An analysis was undertaken by our department, comparing the content of large group resource sessions scheduled throughout the four years of the PBL curriculum with that of the lecture series covered during the student's third year in the previous curriculum. We found that the material covered was similar with some additional material given in the PBL course relevant to a particular

problem (e.g. an LGRS about the drug treatment of acne, given during the week where a problem concerning adolescence was being discussed in the Growth and Development theme.) There was one area where contact teaching differed: the original pharmacology course included lectures giving broad overviews of topics such as 'the Autonomic Nervous System' and 'the Effects of Drugs targeting Dopamine Receptors'. Although an attempt was made to link these topics to one of the problems in the PBL curriculum, they did not often fit well with the problem in question. Because an understanding of these topics was not necessary to deal with the problems that formed part of the PBL curriculum, they did not form part of the students' learning objectives for the theme in question.

The first objective was to assess the level of student confidence in their prescribing judgments to determine whether lack of prescribing confidence was a general problem for all students. A second key research question was whether the lack of prescribing confidence voiced by the students related to an underlying lack of competence. I also wished to explore whether the level of confidence and competence changed across different areas of pharmacological knowledge and skills. I was interested in looking at what was different about this PBL curriculum group compared with previous groups following the traditional curriculum that caused this group to bring this problem to our attention. My final objective was to determine whether, if carefully designed, the short intense contact sessions that had been requested by the students could change their level of prescribing competence and confidence. How should this intervention be designed to afford students the best opportunity to learn?

Chapter 2 LITERATURE REVIEW

The Goal

Educating for Africa

According to the Cape Town Declaration (WHO Regional Office for Africa, 1995), the education and training of a Doctor for Africa should be designed so that he/she is equipped to serve communities in Africa, such training being of an internationally recognized standard of excellence. The focus of education should be oriented towards producing generalists, with a shift in emphasis from curative to comprehensive health care. This document recommends learning strategies developed in response to an integrated core curriculum adapted to local conditions.

Prescribing issues

Drug spending in South Africa accounted for 11.7% and 36.6% of the recurrent health budgets in the public and private sectors respectively in 1998 (Ntuli, 1998). Aims of the National Drug Policy (National Drugs Policy for South Africa, 1996), published in 1996 as part of post-apartheid National Health Policy, included the promotion of rational drug use and the reorientation of the education of health care professionals toward the principles underlying the NDP.

Irrational prescribing is a common problem (Walley & Bligh, 1993). Bad prescribing habits lead to ineffective and unsafe treatment, harm to the patient and higher costs. They also make the prescriber vulnerable to influences causing irrational prescribing, including patient pressure, imitation of colleagues and marketing. New graduates will copy their

practices, perpetuating the problem (De Vries et al., 1994). De Vries et al. (1995) refer to irrational prescribing as "a habit which is difficult to cure".

In an article describing the cognitive processes of doctors making a prescribing decision for a patient, Denig et al. (2002) report that decision processes were not extensive. The decision processes of the doctors studied were not extensive. They did not consider all possible relevant information and habitual behaviour, defined as making a treatment decision without any specific contemplation, was observed in 40% of cases. In this study, the decision-making process was categorised according to the number of treatments and aspects relevant to the treatment choice (such as considerations of cost or of adverse effects) that were considered.

Teaching and learning issues

The Quality of Therapeutics Teaching

The root of this problem appears to lie in undergraduate teaching. Therapeutics teaching is overlooked worldwide. Maxwell et al. (2003) write of a "pressing need for medical graduates to be fully prepared to take on the responsibilities of prescribing and to be able to respond to continual inevitable changes in therapeutics." However, a survey of medical schools in the UK highlighted concern that insufficient time and resources were allocated to pharmacology and therapeutics teaching (Wally et al., 1994). In one study, a group of University of Leeds Medical Students all raised the need for more therapeutics teaching in the undergraduate medical curriculum, and said that their clinical training provided insufficient teaching of therapeutics (Ward & Miolszewski., 2002). These views are

widely supported and clinical pharmacology training throughout the medical curriculum is advocated (General Medical Council, 1993). The traditional focus in pharmacotherapy teaching has been on the transfer of knowledge about drugs, rather than on teaching the skill to treat patients. The result of this approach is that although pharmacological knowledge is acquired, practical prescribing skills remain weak (Hogerzeil et al., 2001).

In order to illustrate this lack of focus on such skills, the situation with respect to one particular prescribing skill is described. The ability to access, critically assess and use practice guidelines is key to rational prescribing. Adherence by clinicians to such guidelines has been poor. One reason for this is that guidelines are seldom included as teaching materials during undergraduate training. Clinicians appear willing to use guidelines if they are given the chance to actively assess the evidence from which these guidelines are obtained. In one study, students given guidelines on the management of diabetes were able to manage standardized patients successfully. In fact, these second year students performed better than standards of care reflected in the published literature. (Brown et al., 2003). These findings support the inclusion of learning opportunities which expose students to practice guidelines and offer practice using evidence-based data.

Variation in student ability and learning needs

Level of prior learning

The act of prescribing is complex and requires a number of skills. Undergraduate medical students vary according to the extent to which they possess each of these abilities. One reason for this is that they have differing degrees of prior learning. Cognitive theory

suggests that learning is a process of knowledge construction, which builds on previous knowledge structures (schemata) already present and which is tuned to the situation in which it takes place (context-dependent). Learning occurs by the interpretation of information where students learn by making sense of new knowledge by mapping it in their existing knowledge maps. Information must be linked to the knowledge structures already present in long-term memory in order for it to be useful. (Resnick, 1989 *loc. cit.* Gipps 1994). Knowledge is stored according to the interests and cognitive structures of an individual, and this facilitates retrieval. (Ausubel 1975, *loc. cit.* Zuber-Skerritt 1992).

The Influence of Learning Styles

Theories about learning styles are manifold. Researchers in the field of learning styles are situated along a continuum that ranges from those who believe that learning styles are fixed, relatively unalterable traits of an individual, to those who believe that learning approach is adopted in response to a particular context, and that it varies according to the context.

Howard Gardner's multiple intelligence theory, made famous in the book *Frames of mind* in 1983, falls among those where learning styles are believed to be a pattern of ability which is a reflection of deep-seated features of the cognitive structure. (Coffield et al. 2004). This theory provides an additional possible explanation for differing student capabilities besides differing experience and educational opportunities. Gardner proposed that people have differing amounts of 7 intelligences: linguistic, logico-mathematical, bodily-kinaesthetic, spatial, musical, interpersonal and intrapersonal. He has since added

a further two intelligences: naturalist and existentialist (Gardner, 1999). As a result of these intelligences people differ in the way they learn, and respond differently to various teaching techniques. Multiple intelligence theory has been embraced by educators as a tool for understanding and effectively meeting the learning needs of their students.

A contrasting view comes from a body of research that believes that a person adopts a learning approach or strategy rather than having a learning style that is an inherent characteristic of the individual. According to this view, the choice of learning strategy is made in response to a particular context. The theories of Marton and Säljö, Pask, Entwistle, Ramsden, Prosser and Vermunt belong to this influential school of thought.

Marton and Säljö, researchers at Gothenberg University, Sweden, explored student ideas about learning and the different ways in which students read an academic article. (Entwistle & Ramsden, 1983). Säljö (1975 *loc. cit.* Entwistle & Ramsden, 1983) classifies the differences in the levels of understanding reached by students reading an academic article into four categories. Students responding in a "conclusion-orientated, detailed" way had a high level of understanding and those who gave a "description, mentioning" response understood poorly. A simple distinction was also found in the way students approached reading an article. Some students intended to understand its meaning, interacting actively with the author's arguments (using their previous knowledge and experience) and who examined the evidence to see how the author's conclusions were justified. The students were said to have adopted a deep approach. Other students mainly relied on a surface approach. They were guided by the assessment

and their strategy was to rely heavily on memorization (rote learning). The Gothenberg researchers found that a deep approach was related to a deep level of understanding and better long term recall of detail (Marton and Säljö , 1976 *loc.cit.* Entwistle & Ramsden, 1983).

Entwistle has led the body of research into learning approaches in the UK. He has drawn on the work of Säljö and Marton, examining greater student numbers from a broader range of disciplines. Entwistle's findings support the notion of deep and surface learning strategies and in addition a further orientation, a strategic approach, is introduced (Entwistle & Ramsden, 1983). Entwistle examines the influence on learners' approaches and strategies of contextual factors such as subject discipline, institutional culture, students' previous experience, curriculum organization and assessment. (Coffield et al., 2004).

Entwistle and Ramsden (1983) identify a further group of students who are then divided into a negative and positive component. The negative component is called non-academic learning. This describes students who showed no motivation, found learning tasks boring and were interested mainly in the social aspects of higher education. The positive component, on the other hand, was called strategic learning. Here, the motivation to learn was extrinsic. The ultimate goal was to achieve success, which was seen as high grades. Students who adopted this strategy were motivated by the need to achieve high marks and to compete with others. Entwistle feels they understand what he calls the 'assessment game,' and learning approaches are therefore defined by the demands of the assessment

task. Medical students come from the ranks of high-achieving high school students, so it is assumed that students who are adept at adopting strategic learning approaches are included among them. In a study of both medical and education students, Desmedt et al (2003 *loc.cit.* Coffield et al., 2004) concluded that because of the curriculum, students are not interested in learning but in assessment.

Entwhistle and Ramsden (1983) found subject area differences in correlations between learning styles and outcomes. Strategic orientation has its strongest positive relationship with progress in the science subjects.

Factors which influence learning style

The attributes for which higher education is valued by society are embodied in the deep approach. Deep approaches were more likely to be associated with higher quality learning outcomes. Those ways of understanding which include more complete ways of conceiving of something are of a better quality than those where conceptions are more limited.

However, evidence suggests that these attributes need greater encouragement by teachers or they are seldom achieved by students. In fact, teaching methods, curriculum structures and, in particular, assessment methods may all actively inhibit the deep approach and support the use of surface and strategic approaches.(Newble et al., 1994).

Marton (1976 *loc.cit.* Entwistle & Ramsden, 1983) stresses that the approach to learning should not be seen as a characteristic of the student but as a response to a situation, so a shift may occur from the natural deep approach to a learned strategy, the adoption of a surface approach, to cope with adverse circumstances. The findings of Entwhistle and Ramsden (1983) show a strong influence between the learning approach used and the situation in which learning takes place. The ability of some students to be better able to 'manage' adverse conditions appears to be a personal characteristic. Students who were orientated towards both meaning and achievement were apparently less affected by adverse teaching and assessment conditions.

Entwistle and Ramsden found too that in relation to science tasks, prerequisite knowledge was most often mentioned as a crucial component of a deep approach. Particularly for science subjects, the probability that students will take deep approaches is increased if enough information and background knowledge associated with the academic task is available.

Students' approaches to learning (deep and surface) have been found to be related to their conceptions of learning and the subject matter. Students who conceive of learning a topic in a limited way (such as learning off by heart to quantitatively increase knowledge) are unlikely to adopt a deep approach to the learning of the particular topic. On the other hand, students who have a fuller conception (who see learning as the abstraction of meaning, or as an interpretive process aimed at understanding reality) are more likely to

adopt a deep approach to learning of that topic. Conceptions of learning and of the subject being learnt are part of a student's prior experience.

Teaching methods may also influence the adoption of a particular learning style. A surface approach is reinforced by a heavy workload and by lecturers who foster dependency by 'spoonfeeding'. A teacher-centred focus, where methods employed include lectures, seminars and demonstrations, fosters surface learning. Methods such as discussions, simulations and problem-solving, where the student is given freedom in learning and encouraged to follow self-directed goals to find meaning encourages the adoption of deep learning strategies. (Ramsden, 1992).Other good teaching practice which fosters a deep approach includes good pace and pitch, real-life illustrations, empathy with students' difficulties, enthusiasm and offering 'lively and striking' explanations (Entwistle & Ramsden, 1983)

The kind of method used to assess learning is key to the adoption of a particular learning approach. If questions requiring rote-learned answers are asked, surface learning is implicitly encouraged and rewarded, and this encourages a shift in student approach toward surface learning. Säljö found that giving students specific factual questions encouraged a surface approach causing students who had initially adopted a deep approach to a shift to a surface approach. Students who adopted a surface approach initially had difficulty moving fully to a deep approach. (Marton and Säljö, 1976 *loc.cit.* Entwistle & Ramsden, 1983). Entwistle & Ramsden (1983) stress the importance of

designing assessments which test understanding, which demand independent thought and which do not seem to reward simple reproduction.

Bloom's Taxonomy

In order to enable educational training and learning objectives to be planned and measured appropriately, testing for the development of 'mastery' rather than for the transfer of facts for mindless recall, Bloom (1956) developed a system of goals for the educational process. This hierarchy of educational objectives, referred to as Bloom's Taxonomy, is divided into three 'domains'.

The first of these, the Cognitive Domain, involves the development of knowledge, and intellectual attitude and skills. The remaining two domains are the Affective Domain (Bloom, 1964) and the Psychomotor Domain, the details of which vary in different representations of the taxonomy because it was not developed by Bloom, but by various people, so several alternatives exist. The categories within each domain are levels of learning development, which increase in difficulty. Within each domain, a category must be mastered before it is possible to progress to the category on the next level. Table 1 shows a simple adapted representation of Bloom's Taxonomy:

Within the Cognitive Domain:

1. 'Knowledge' represents the lowest level of learning outcomes. This is defined as remembering previously learned material, ranging from specific facts to complete theories, where all that is required is the bringing to mind of the appropriate information.

2. 'Comprehension', defined as the ability to grasp the meaning of material, represents a learning outcome a step higher than the simple remembering of material. Comprehension represents the lowest level of understanding and may be shown by translating material, by interpretation of material through explanation or summary and by the prediction of consequences or effects.

3. 'Application' refers to the ability to use learned material in new and concrete situations. Application requires a higher level of understanding than those under comprehension and can be demonstrated by the ability to solve a mathematical problem, to apply a concept to a new situation or a theory to a practical situation.

4. 'Analysis' refers to the ability to break down material into its component parts so that its organizational structure may be understood. Learning outcomes require an understanding of both the content and the structural form of the material. It includes the identification of parts, understanding the relationship between parts and recognition of the organizational principles involved.

5. 'Synthesis' is used to describe the ability to put parts together to form a new whole. Learning outcomes emphasize the formulation of new patterns or structure. Synthesis is needed to produce a piece of creative writing, to propose a plan for an experiment and to formulate a scheme for showing the relationship between areas of knowledge.

6. 'Evaluation' is the ability to judge the value of a creative work such as a poem, film, a statement or a research report. Learning outcomes are considered to be highest in the cognitive area because they contain elements of all the other categories as well as conscious value judgments based on clearly defined criteria.

If a deep approach is to be fostered, assessment methods which require higher level cognitive skills and which where possible include the assessment of affect should be used. Assessment methods are discussed further in the chapter on Implementation.

Fostering versatility

Pask and his colleagues (Pask and Scott, 1972 *loc.cit.* Entwistle & Ramsden, 1983) looked at the strategies students used to reach a deep level of understanding, and their findings provide an insight into the different ways that people arrive at a deep level of understanding. They found two distinct categories which they called holist and serialist strategies, which they feel describe the different ways in which people solve problems. The 'holist' style is called comprehension learning and involves building descriptions of what is known. The 'serialist' style is called operation leaning, the part of the learning process concerned with mastering procedural details. Versatility, the combination of operation learning and comprehension learning, is especially favourable to progress in the science departments. However this versatility in learning emerges readily only where the workload is reasonable, where freedom of learning is allowed and where the assessment methods are consistent with the teacher's attempts to develop critical thinking.

Reshaping into new wholes

The concept of holism, that everything is inevitably interrelated and mutually dependant, is central to Gestalt theory (Kirchner,2000). The whole is more than, and different from the sum of its parts. According to the Gestalt view of human nature, human beings are whole makers, synthesizers of a wide variety of bodily, perceptual, cognitive, behavioural and existential gestalts (a word which cannot be translated into an equivalent, single English term but which encompasses a wide variety of concepts such as a shape, a pattern, a whole form, and a configuration). Representatives of Gestalt psychology demonstrated that an individual organizes his/her perceptions into meaningful sets. This principle of perception became a basic concept in Gestalt theory, which includes the individual's tendency to perceive wholes even where information is missing. Learning and change is the result of how an individual organizes his/her experiences and assimilates novelty. Human beings can neither refrain from meaning making nor from organizing and reorganizing themselves as they have new experiences. Our wiring for meaning always emerges contextually and relationally, which brings us to the other major concepts, besides the capacity for making wholes in which Gestalt theory is grounded. These are biological field theory, the need for contact and the entity of the organism.

The field concept believes that all organisms exist in environmental contexts with reciprocal influences on each other. No organism can be reduced to separate components but can only be understood in its organized, interactive, interconnected, and interdependent totality. The organism is considered to be an ordered whole, intrinsically self-regulating individual, seeking growth towards maturity and the fulfillment of its

nature. Organismic behaviour is not random, but purposeful and goal-seeking. Contact, the 'lifeblood for growth' is paramount for survival and change. It is understood as the responsive meeting with the other (this being either an environmental or internal other, whatever is not integrated and therefore not experienced as other). It is also the forming of a figure against a ground and defined as 'the creative adjustment of the organism and the environment', neither one existing without relating to and being informed by its counterpart. (Kirchner, 2000).

With the concepts underpinning Gestalt theory in mind, Prosser's presage-process-product model (Figure 1) shows how a student learning approach cannot be considered apart from its context. This model shows how student characteristics (including previous experiences and current understanding) and how contextual factors such as course design, teaching methods and assessment influence the students' perceptions of context, which in turn influences the learning approach the student will take and ultimately affects the learning outcome. (Prosser et al., 1994 *loc.cit* Prosser & Trigwell, 1999).

Closely linked with the research into deep and surface learning is the work of Vermunt, (1996 *loc.cit.* Coffield et al. 2004) whose model identifies 4 learning styles, which form a hierarchy increasing in efficiency. His model also aims to integrate the contribution to learning of various kinds of mental processing in addition to cognitive processing. According to his framework for classifying learning styles, four learning styles are defined: meaning-directed, application-directed, reproduction-directed and undirected.

Meaning-directed learning is associated with the highest order of cognitive ability and undirected learning with the lowest. Each is said to differ in five areas:

1. the way in which students cognitively process learning contents (what students do);

2. the learning orientations of the students (why they do it);

3. the affective processes that occur during studying (how they feel about it);

4. the mental learning models of students (how they see learning);

5. the way in which students regulate their learning (how they plan and monitor learning);

In addition to cognitive processing he considers the relationship between learning and affective characteristics, those which relate to an external expression of emotion associated with an idea or action, such as motivation and feelings. He also looks at conative or volitional characteristics (which involve will, impulse, desire or resolve) such as effort. Finally the role of metacognitive processes (the ability to think about thinking) and self-regulation is emphasised. Metacognition is discussed more fully below. Table 2 shows Vermunt's learning styles with illustrations of their components, suggesting linked sets of behavioural cognitive, affective, conative and metacognitive characteristics. The framework is intended to be flexible. Learning styles are not considered necessarily to be

mutually exclusive and links between the areas may differ. (Vermunt, 1996 *loc.cit.* Coffield et al., 2004)

The influence of Metacognition

This is the term which refers to second-order thinking, to thinking about thinking. It is the ability to set personal explicit challenging goals; to identify strategies to reach these goals and to monitor progress towards them. It includes a range of self-awareness processes which foster an explicit understanding of one's own knowledge and thinking. This self-awareness allows an individual to plan and control his/her own learning. The development of metacognitive processes is encouraged because it is believed that learners who have insight into the way they learn are able to have greater control over their learning and are moving towards becoming self-motivated or autonomous learners (Holmes & Ramos, 1991, cited in James & Garrett, 1991: 198-212). According to Sadler-Smith (2001 *loc.cit* Coffield et al., 2004), the potential of self-awareness and metacognition is in 'enabling individuals to see and to question their long-held habitual behaviours; individuals can be taught to monitor their selection and use of various learning styles and strategies. Teaching strategies which focus more on the process of knowledge acquisition rather than on the knowledge itself are believed to help students think about their own learning. Marzano (1998 *loc.cit.* Coffield et al., 2004) has conducted research in support of improving metacognition, finding that approaches which were set at the metacognitive level of setting goals, choosing appropriate strategies and monitoring outcomes were more effective in improving knowledge outcomes than

those which simply aimed to engage learners at the level of presenting information for understanding and use.

The role of Motivation

Bloom recognised the importance of motivation in the learning process, and within the Affective Domain, the first step in the development of an attitude or belief is the ability to 'receive': to be willing to hear, or to be open to experience (Bloom, 1964). At a very simple level it is necessary to attend the learning session or to pick up the book in order to learn.

Apter's integrative theory, (Coffield et al., 2004, p.52). outlined in Table 3, provides a structure for understanding human behaviour and experience by characterising the dynamic interplay between opposing motivational states. It makes predictions about thinking, learning and behaviour and it acknowledges the interaction between cognition, emotion and volition.

Mental processing is seen to involve changes within and between four domains: means-ends, rules, transactions and relationships. Apter believes that 'within domain' motivational state reversals (e.g. switching from serious goal-directed work to playful recreation) ensure 'that the individual has a possibility of every type of psychological satisfaction'. The frequency and extent to which an individual switches between motivational states is thought to be influenced by situational factors as well as genetic or unconscious factors. Individuals also differ in the time spent in various motivational

states and in their perceived importance. Each motivational state is driven by a core psychological need and is characterised by a particular style of interacting with the world. A range of emotions is associated with each motivational style. Underlying reversals in one or more of the four experiential domains are believed to cause reversals between emotions, such as a switch from excitement to anxiety. Two key reasons for switching between motivational styles are believed to be frustration and satiation.

Importantly for teaching and learning, this theory suggests that productive learning styles can be produced by fostering creative learning environments through which important values are conveyed and in which reversals through boredom on the one hand and frustration on the other are less likely to occur Also, an understanding of the various elements which produce different states of motivation in different contexts can allow people greater control over their motivation and consequently of their learning. (Coffield et al., 2004, p.52).

Back to Basics

One of the logical deductions following from Entwistle's research (Entwistle & Ramsden, 1983) is that a course should be designed to take account of the students' current knowledge base in a subject and the level of understanding of the discipline that students show on entry. Another recommendation based on his research is that teaching should be related to previous knowledge, with remedial materials to overcome gaps and common misunderstandings.

Whether learning styles are fixed traits or whether they are affected by context, and however small the effect of learning style is on overall learning outcomes, a teaching approach which deals with both generalities and particulars still appears to assist learners. Teaching strategies should include material structured so that part-whole relationships are clear, they should encourage both deductive and inductive reasoning and employ both visual and verbal forms of expression (Coffield et al., 2004).

Vermunt and Verloop Vermunt and Verloop (1999) recognise that learners pass through differing stages as they develop autonomy, with a shift occurring from low to high levels of student regulation and stronger to lower teacher regulation with increasing autonomy. Constructive friction occurs in situations where the teacher expects the students to perform with greater self-regulation, pushing students to take more responsibility. In contrast, destructive friction occurs when students are capable of more autonomy than their teachers allow or when they are incapable of taking responsibility for their own learning. These ideas imply that teachers need to understand their students well and to become more versatile in the roles they adopt (Vermunt & Verloop, 1999 *loc.cit.* Coffield et al., 2004).These concepts also fit well with Apter's research which suggests that frustration or satiation is likely to cause a student to switch between motivational styles and disengage from learning (Apter, 2001 *loc.cit.* Coffield et al., 2004). Grasha (1984 *loc.cit.* Coffield et al., 2004) argues that people need to be 'stretched' and stretching may mean deliberately creating a mismatch between learning styles and teaching methods. These concepts reflect the balance between support and challenge that a student needs in order to learn.

A Response to the goal

Problem-based Learning

Self-directed learning is an educational approach which involves the learner as an active participant. (Spencer & Jordan, 1999). Learners can choose learning activities that suit the way they learn and accordingly it is not surprising that self-directed learning has been found to encourage a deep approach to learning, where learning is based on an understanding of concepts rather than on rote learning, and which improves retention of knowledge. Self-directed learning is the approach most likely to make doctors life-long learners and to prepare them for continually changing practice.

Problem-based learning (PBL) is one of several teaching strategies that have been developed to encourage self-directed learning. It is unlike traditional approaches, in which the new knowledge is provided before attempts to solve problems. Instead students start with a specific problem (usually written) of "phenomena that need explanation". They identify issues which this problem raises, to help develop understanding about underlying concepts and principles. New knowledge and understanding arise through working on the problem. PBL applies principles of learning acquisition: it activates prior knowledge, which determines what can be learnt subsequently; it allows for learning in context, which enhances transfer of knowledge to real situations; it allows for the elaboration of material, which enhances subsequent retrieval; and its inquisitive style allows for the development of information seeking

techniques. Problem-based learning appears to foster a deep approach, as can be seen by the findings of Newble & Clarke (1986) who report that more students from a problem-based medical school adopted a deep approach and fewer adopted a surface approach compared with students from a traditional school.

Several disadvantages of PBL have been identified, including expense, excessive demands on staff time, increased stress for students and staff, reduced acquisition of knowledge of basic sciences, and implementation difficulties when class sizes are large or where there is lack of enthusiasm for the approach (Spencer & Jordan, 1999).

The P-treatment Approach

This is a rational treatment approach which has been developed as a response to the problem of poor prescribing and has been heralded as the way to prevent irrational prescribing. Also known as the P-drug approach, it is outlined in a manual, the *Guide to Good Prescribing* (De Vries et al., 1994), designed for undergraduate medical students by the WHO Department of Essential Drugs and Medicines Policy. The manual presents students with a normative model for pharmacotherapeutic reasoning. First, students are taught to develop a standard treatment for common disorders, resulting in a set of first-choice drugs, called P(ersonal)-drugs. Students are taught to consult existing treatment guidelines, formularies, textbooks and other available sources of information. Then they are shown how to apply this set of P-drugs to specific patient problems, using a six-step problem-solving routine:

1. define the patient's problem;

2. specify the therapeutic objective;

3. verify the suitability of your p-drug and choose a treatment for this individual patient;

4. write a prescription;

5. inform and instruct the patient;

6. monitor and/or stop the treatment.

The rationale behind this approach is that medical students develop, during their studies or early in their career, a set of drugs which they will use regularly. This manual helps students to select P-drugs in a rational way, avoiding the early pressures of copying the prescribing behaviour of clinical teachers or peers without consideration, as well as later pressures from commercial drug promotion. It also helps students use existing treatment guidelines appropriately, teaching them how to validate, and if necessary adapt, a generally recommended treatment to suit an individual patient (Hogerzeil et al. 2001).

Development of learner independence

Teaching therapeutics using the p-drug process shifts the perspective of learning from one where only *product* (i.e. the outcome, such as an appropriate drug for a particular

problem) is important. The p-drug process emphasises instead the *process* of drug selection. It helps students think about their own learning, enhancing metacognitive abilities. For example, it helps them think about how they have made treatment decisions in the past and upon what basis these should be made in order that they are rationally-based and up-to-date. Improving metacognitive ability gives a student the tools to take responsibility for his/her own learning , allowing for more autonomy which increases motivation, developing self-confidence and subsequently competence.

Chapter 3 CONCEPTUAL FRAMEWORK AND CORE CONCEPTS

Conceptual framework

Most of my experience as a learner, teacher and researcher has been with cognitive research. I am comfortable and confident within this positivist paradigm so my natural impulse was to use methods located in this framework to answer my research questions. A key characteristic of cognitive research is that it is underpinned by a philosophy which is dualist in nature, meaning that the individual or subject is believed to be a separate entity from the phenomenon or object. Researchers endeavour to treat data objectively so that their results are not skewed by bias. They may also introduce a measure such as blinding, for example, to prevent study subjects from being influenced by the object being tested and introducing bias into the results. Researchers strive to strip the object of study from possible confounding (a difference in results caused by contextual (co-occurring) factors, so that results can be thought to apply to unrelated settings. Randomised sampling of study subjects is desirable so that results can be generalised to the population from which the sample is drawn. An advantage offered by this kind of research includes representativeness: that conclusions reached about a representative sample may be applied to the population as a whole.

However, the positivist approach to the study of human behaviour has been criticised because it fails to consider the unique ability of the human to interpret and represent experiences and it ignores or presumes its subjects' interpretation of situations. Interpretive research approaches probe the accounts of a study subject's actions in order

to understand what the subject was doing during a particular social episode of interest. (Cohen and Manion 1980).

I have used two kinds of qualitative approaches to complement the quantitave part of my study. Trigwell gives a clear description of these methods, illustrating their differences with a pictogram, included in Fig 2 (Trigwell, 2000). These are non-dualist in nature, with reality seen as being constituted as the relation between the individual and the phenomenon. They are also second order approaches, where the experience of the phenomenon being studied is described by others and this description forms the basis of the researcher's description. This differs from a first-order approach, where the researcher perceives and describes the phenomenon.

In order to examine the variation in the students' reasoning during the prescribing process and to uncover possible differences in their conceptions of prescribing that might account for any variation, I conducted in-depth interviews using a **phenomenographic** approach. In order to look more deeply at the reasons behind the level of prescribing confidence and capability and to explore other key issues that emerged from student interviews, I used a **content analysis** approach.

Phenomenography is the study of the limited number of qualitatively different ways in which a phenomenon is experienced. It has its roots in the studies concerning learning conducted by the Gothenberg researchers encountered in the previous chapter. (Marton and Säljö, 1976 *loc. cit.* Entwistle & Ramsden, 1983). The phenomenographic approach

focuses on key aspects of the variation in the ways a phenomenon is experienced. Awareness is understood as a person's total experience of the world at a given point in time, and is conceptualised not as the dichotomy aware/unaware or conscious/subconscious, but as being characterised by an infinitely differentiated figure-ground structure. Certain things are in the foreground, others in the background: implicit, unthematised. The more that things which are unthematized and implicit are regarded as objects of reflection and henced thematized and made explicit, the more fully do we explore awareness. The critical aspects in these different ways of experiencing are captured to give *categories of description.* The internal relations between these categories are then described to produce an *outcome space.* The different ways of experiencing a phenomenon represent different capabilities for understanding that phenomenon. Since some ways are more efficient than others in relation to some given criterion, a hierarchy of categories of description can be established. The focus is on differences, resulting in a partial description of the experience of a phenomenon, with ways of experiencing the phenomenon that are common to the group not being included. The analyses and descriptions of outcome of learning are viewed as the product of phenomenographic research. (Marton et al. *loc cit.*, Land of Phenomenography website).

In contrast to phenomenography, no internal relations are sought between the key themes identified using the content analysis research tool.

Cohen and Manion (1980) explain that the perspectives of both normative and interpretive approaches are necessary and inseparable aspects of understanding human

behaviour and experience. Neuman (2000) in his chapter on qualitative and quantitative research designs discusses triangulation of method, explaining that this mixing of quantitative and qualitative styles of research and data can be used so that the research benefits from the different but complementary strengths of each approach, resulting in a fuller, more comprehensive study. Entwistle & Ramsden (1983) argue that 'neither qualitative nor quantitative methods of research taken separately can provide a full and convincing explanation of student learning'. They too feel that a mix of both quantitative and qualitative research is essential to understand student learning. They believe that this should 'be built up from an appropriate alternation of evidence and insights derived from both qualitative and quantitative approaches to research.'

Each of my research objectives would benefit from these complementary research perspectives. I therefore sought to complement the breadth of the data I expected to elicit from employing positivist research methods (three fixed-response questionnaires) with 'in-depth' insightful information which might be disclosed in an interview situation.

Core concepts

Reasoning

According to the Encarta English Dictionary (U.K.), reasoning is defined as the use of logical thinking to find results or draw conclusions. In logical thinking, an argument is developed consisting of a set of statements, one of which is the conclusion, the others being premises. The premises support the conclusion. The argument thus consists of a statement along with the evidence that supports it. Deductive reasoning is used when we

begin with things we know are true, put them together and follow them to the conclusions to which they lead. A deductive argument is one in which the conclusion is certain based on the premises. In a deductive argument the conclusion is contained in the premises. On the other hand an inductive argument is one in which the conclusion is *probable* based on the premises. In an inductive argument the conclusion goes beyond the premises.

Prescribing confidence and competence

The concepts "prescribing confidence" and "prescribing competence" need further elaboration. In addition it is necessary to examine the relationship between these two phenomena.

Confidence has been defined as an attitude based on a belief that a person has the ability to do something effectively (Bleicher & Lindgren, 2002). Therefore prescribing confidence would be a student's belief that he/she will be able to prescribe an appropriate treatment for a patient in their care. Confidence has been equated with the psychological construct of self-efficacy. Albert Bandura's theory of social learning provides a useful framework showing the relationship between what he calls self-efficacy expectation and motivation to perform an action (Bandura, 1977, 2000 *loc. cit.* Bleicher & Lindgren, 2002). According to this theory, we are motivated to perform an action if we believe the action will have a favourable result (outcome expectation) and we are confident that we can perform successfully (self-efficacy expectation). This notion, that the students' self-confidence in their ability to tackle a task fundamentally affects their approach and understanding, is supported by a strong evidence base. (Carlisle, 2000).

Stewart et al. (2000) reported British house officers' understanding of the construct 'confidence' to be a word that "described a judgement which influenced whether an individual was willing or not to undertake an activity". The house officers in Stewart et al's study understood 'competent' to represent what individuals knew about their ability and this construct was based on the individual's previous experience of the task. Gipps differentiates between competence and performance, where 'competence' refers to the ability of an individual to achieve under ideal conditions, while 'performance' is measured under existing conditions. 'Competence' includes motivational, affective and cognitive structures as well as the ability to access and use knowledge structures. (Gipps,1994).In relation to prescribing, confidence is needed for the motivation to perform the actions that will ensure an appropriate script.

However, confidence does not seem to be a linear construct, making measurement a problem (Carlisle, 2000). In the Stewart et al. (2000) study the expression of confidence related to perceived competence while the expression of a lack of confidence related to anxiety and feelings of uncertainty. Furthermore, the relationship between confidence and competence is not directly proportional, with an increase in confidence not always linked to an immediate increase in competence (Carlisle, 2000). For example, in a Canadian intervention designed to teach medical students how to break bad news, Garg et al. (1997) report that despite an overall improvement in perceived competence (a measure of confidence), 11 students decreased reported a decrease in perceived competence as a

result of the course. The researchers attributed this to a possible loss of preconceptions and to the gaining of a more realistic view of the difficulty of the task.

Chapter 4 IMPLEMENTATION

Study design

Pre-intervention test

Reflection upon Gardner's Multiple Intelligence theory (1993;1999) caused me to think about the kinds of intelligence and skills that are needed for an individual to prescribe competently, and in consultation with other staff members I developed a list of key prescribing skills. In order to determine which skills and areas of knowledge needed attention, I prepared a test covering a broad range of material, including core topics, designed to test these key prescribing skills (see Appendix I). Table 4 gives a breakdown of these skills and the particular examples of material used in each case. Test questions consisted of 8 short questions requiring written responses, and 12 problems, each followed by five true/false questions associated with the problem but unrelated to one another. Students were also asked to rate their level of confidence in the correctness of each of their true/false answers on a scale of 1-10. The test was administered before the start of a compulsory lecture to ensure that a high percentage of the class received and completed the test. Students each signed consent to participate in the test on the understanding of anonymity. Results of the test were analysed using Epi-Info Version 3. As data was normally distributed, (Bartlett's test for equality of population variances was used to check this), parametric tests (T tests) were used to compare the confidence ratings of students answering correctly and incorrectly.

Methodological issues

Two types of assessment were used in the tests. The first type was a context-dependent question, which is a form of objective test where a question with a complex stem is developed using stimulus material. Examples of the kind of stimulus material we used were graphs (two questions), treatment guidelines (one question), a printed advertisement graphic (one question), clinical scenarios (six questions), a clinical scenario with diagram (one question) and a clinical scenario with treatment guidelines (one question). These were each followed by five true/false questions associated with the stimulus material but unrelated to one another. This assessment form was chosen because students are familiar with this kind of question which is used extensively in their formal assessment. Such questions may require a degree of analysis, a higher-order cognitive ability than the simple true/false test which assesses mainly recall and recognition of factual information. (Newble & Cannon, 1994) believed that setting the true/false questions within a context in this way may overcome problems associated with the traditional true/false question, some of these being that misinterpretation is common, that relevance to problems in real practice is often lacking and that there is often little focus on interpretation of data and problem solving. (Hogerzeil et al.,2001).

In addition to the context-dependent questions, questions requiring short written responses were included to broaden the assessment method mix. These were familiar to the staff because they had been used as part of the assessment for the previous curriculum. They included restricted response essay questions, short answer questions and modified essay questions (comprising respectively 39%, 27% and 33% of the marks

allocated to written response questions.) Restricted response essay questions require an explanation, comparison or description; short-answer questions require a factual recall of a word or phrase; and modified essay questions require short answers or explanations given in response to a case and some patient data (Newble & Cannon,1994).

With Bloom's Taxonomy in mind, the importance of assessing the development of the competence required for the skill of prescribing was understood and we aimed to assess higher order cognitive ability where possible. The test was rated against Bloom's Taxonomy, and a Bloom Domain, which best described the cognitive ability being tested in each question was assigned. Table 5 gives the proportion of the test questions expressed as a percentage that can be ascribed to each Domain.

Interviews

Using the results of the pre-intervention test, 10 students were selected from across the spectrum of results, which ranged from 31 to 74%. A stratified sampling procedure was chosen for the selection of interview candidates, because the phenomenographic part of the study focuses on the variation in ways people experience a phenomenon, so the sample had to be selected to maximise the possible variation. The sample was stratified to ensure representation from each of the following groups of results: 30-39%, 40-49%, 50-59%, 60% and over. Stratified sampling was chosen in particular to increase the possibility of picking up the variation present within the group. These students were invited to attend an interview and, after giving written informed consent, were asked to consider the prescribing problems of four paper cases and to prescribe appropriate

treatment for each. Table 6 gives details of the paper cases discussed in student in-depth interviews.

The 'think aloud' method was used to elicit the students' decision processes and to give insight into their conceptions of prescribing. "Think aloud" is a process tracing method which reveals the cognitive processes that are involved in the decision–making process, without affecting the outcome of the decisions. Subjects are asked to verbalise all thoughts that come into their mind while performing a decision task. Most people are able to do so after a little practice; the only side effect is that it may slow down the decision processes, since most people are not fully aware of all the thoughts that crossed their minds before the final decision is made and tend to make hindsight rationalisations. The most important limitation of the 'think aloud' method is that not all thoughts can be verbalised. For example, recognition of and reaction to non-verbal stimuli, such as smells or patterns, are difficult to verbalise. Furthermore, automatic thought processes are often one step procedures of which only the outcome will be verbalised (Denig et al, 2002).

General comments about the course and the proposed intervention were also encouraged. The interviews were recorded, transcribed and analysed first according to key themes using the qualitative research tool QSR NVivo version 2.

Next the portion of the transcripts relating to prescribing problems concerning asthma (question A) and otitis media (question B) were then scrutinised in an attempt to identify whether responses could be ranked according to the variation between them. The student

transcripts were examined to determine the reasoning and conceptions related to prescribing that these responses revealed. Each understanding was described carefully in order to bring out its special characteristics relative to the others, together forming a set of categories of description. A logical relationship between the different ways of understanding the text was sought in an attempt to establish a hierarchy between the categories of description, and to produce the set of categories known as the outcome space.

When analyzing the results the investigator was blinded to the student's test result.

Intervention design

A week (15hrs) of intensive tutorials was designed and offered to all students who were interested and who were able to attend. Areas of weakness highlighted during the test and student interviews were used to determine the content of in the intervention. Included was a focus on each of the key prescribing skills that had been identified so that there was an opportunity for competence to develop in each area. A mix of learning strategies was employed. Large group sessions had a basic science focus, covering general overviews of pharmacokinetics, autonomic pharmacology and principles of antimicrobial treatment (6 hours). A question and answer session was used to teach students how to use package inserts to find injectable antibiotic administration information and to calculate dosages 1 hour). In the small group work sessions, students were presented with paper prescribing problems. Using South African Standard Treatment Guidelines books and following the

P-drug process, students then worked together to write an appropriate prescription which was then discussed with the rest of the class (8 hours).

Post-intervention test

I hoped to compare the change in test results and in confidence ratings for the group participating in the intervention with a control group, those who had not attended the sessions. Accordingly, the therapeutics test was repeated after the intervention. Unfortunately, logistic difficulties together with lack of student willingness resulted in a sample of participants that was too small for any conclusions to be drawn by comparing their results with those of the test conducted prior to the intervention. As a result data pertaining to this repeat therapeutics test was excluded from further analysis.

Student evaluation

Students who had participated in all or part of the intervention were subsequently asked to evaluate the programme during a standard lecture session. Having given written informed consent they were asked to rate their abilities for key areas for prescribing competence before the intervention and to rate on a scale of 1 to 5 how they felt their abilities changed as a result of the intervention. The questionnaire is included in Appendix. II. These abilities were a composite of the required skills listed in Table 4.

Chapter 5 ANALYSIS

Pre-intervention test

The pre-intervention test was completed by 124 students of a total class of 170 (73%). Thirty four students (27%) scored 50% and above, and the average mark achieved was 47%. Students did not fare well in the short answer questions, attaining an average of 21%. They did better (69%) in the true/false questions in which wrong answers were not negatively marked.

Tables 7a and 7b show the results achieved for the short answer questions and the true/false questions respectively. For the latter the median confidence rating, which ranged from 3 to 8 (with an average level of 4 on a scale of 1 to 10 for responders) is indicated in the last column. The Bloom Domain associated with each question is also shown.

For the short questions, the best result (41%) was obtained for a question testing counselling skills which was judged to test knowledge and application. The worst result (5%) was obtained for a question testing dosage calculation, a question judged to be testing the high-level cognitive function of integration. For the true/false questions, students achieved the best result for a question testing literacy (84% with a median confidence rating of 7). This question was judged to be testing knowledge (80%) and comprehension (20%), ranking low in Bloom's Taxonomy. For two of the five parts of this best answered question, there was a statistical difference between the mean confidence rating for those students who answered the question correctly and those who

did not, the confidence rating being greater for those who answered correctly (Table 7c). The worst result was for a question about testing interpretation of drug levels (48%, confidence rating 5). Here again two parts of the question showed a statistically significant difference in confidence ratings. In one part the students who answered correctly were actually less confident than those who did not; For the other part, though students who answered correctly were more confident than those who did not, the difference in confidence between these two groups was much less than that seen in the best answered question.

Interviews

Table 8 shows the themes extracted from the interview transcripts. It includes all the themes identified apart from two categories which are handled separately in tables 9 and 10.student (student mistakes and problems identified by the students). Lack of confidence was a recurring theme throughout the interviews (see Table 8).

Table 11 gives a breakdown of the interviewees' treatment decisions. Appropriate treatment was given by two of the ten students for case A (asthma), and by one of the ten students for cases C (statin-induced myalgia) and D (osteoarthritic knee). These three students ranked first, fourth and eighth according to test results. No student gave both an appropriate antibiotic and analgesic medication to treat paediatric otitis media (case 2) or suggested delaying antibiotic treatment or giving a hold prescription so that the patient could wait for a time and only start treatment if the infection did not resolve spontaneously within this time. In all the cases important information to be given to the

patient was mentioned by only one student. This student's test results ranked fourth. Eight students said that they would seek information in the South African Medicines Formulary. Two students, who rated seventh and eighth in the test, considered efficacy, safety, suitability and cost when making their treatment decisions. A further seven considered at least one of these criteria, together with efficacy, while reaching a prescribing decision.

Tables 12 and 13 give the outcome space developed from what was revealed of students' conception of prescribing from the transcript subsets relating to uncontrolled asthma (table 12) and otitis media (table 13). In Table 12, the variation appears to fall within five categories. The student falling within the first category, representing the simplest level of understanding, appeared to understand prescribing as giving medicines treat symptoms. In the following category, the disease was conceived as having levels of severity and treatment decisions depended upon the level of severity with which the patient presented. In the third category of description, students also considered further aspects in making a treatment decision. Two students considered negative aspects of drugs such as their side effect profile and cost and patient inconvenience involved in accessing the drug. Two others considered that a patient's receiving a drug prescription is not the same as the patient taking that medicine. Issues such as affordability and access were again considered as well as whether the patient was able to use the inhaler prescribed appropriately. One student considered both the former negative drug aspects and the latter patient adherence aspects. In the fourth category the concept of prescribing was broadened from the selection of medicines to the selection of treatment, which included

Intervention

One hundred and six students (62% of the class) attended all or part of the intervention (85% of those tested). Many of the students who did not attend were unable to do so because it was scheduled during the vacation when they were traveling to homes far from Durban.

Student evaluation

On the day of the evaluation 79 students were present in the class (46 % of whole class). Evaluations were obtained from 60 students (57% of the students had who attended the holiday sessions). Table 14 shows the median initial student rating of key prescribing abilities, as well as the change in these ratings after the holiday sessions.

Students contributed detailed comments in the open-ended section of the questionnaire. These were all very positive. Strengths of the course which were highlighted included student-department relations, group work and time on task: some students liked having the intensive focused block of time. Several students reported that they felt a weakness of the sessions was that they were not assessed.

Suggestions for future improvements were also given. Most frequently requested was that these tutorials be given as part of the curriculum early in the students' training. Further requests included follow-up with prescribing exercises within each theme throughout the course and assessment of sessions.

Chapter 6 DISCUSSION AND CONCLUSION

This study was conducted in response to a lack of confidence voiced by the students in an attempt to find out why this particular group of students was experiencing problems, to figure out what exactly the problems were and to find the best way to help the students learn to prescribe competently with confidence.

The lack of confidence could be symptomatic of the insecurity ascribed to Vermunt's non-directed learner (Coffield et al 2004), who is also a seeker of support from the department and peers. On the other hand, it is possible that this particular group, through their exposure to PBL, a style of learning which encourages students to identify gaps in their understanding and develop strategies for improvement, may have been better able to ask for help compared with previous cohorts of students, who may not have identified a problem that has always been present. In this study, students describe becoming aware of their lack of prescribing ability when faced with the experiential learning component of their clinical skills programme in their final year. This compares to the findings of a departmental study (*An evaluation of the MBChB 111 Course 2000,* unpublished). There students following the earlier traditional medical curriculum which was not problem-based and where pharmacology was encountered in the third year made positive and encouraging comments at the end of their pharmacology course. However, students graduating in the same year felt that the course had not prepared them adequately for their clinical years of study.

Differences between the students in this study and the students of earlier years may occur at the level of affect, with all students perceiving a problem with lack of prescribing competence (corresponding to Bloom Affect category of reception). The students in this study may have also moved to the next affect level of responding to the problem with a request for help.

Pre-intervention test

Students had no prior warning of the pre-intervention test, and the results were poor, with less than a third of students obtaining 50% and an average result of 47%. In a recent South African study, of students who had graduated but not yet registered, prescription writing was the worst performed skill of those tested, with a score of 55.3%. (Burch et al. 2005). These findings are in keeping with the worldwide trend of overlooking therapeutics training (General Medical Council, 1993). The focus of most PBL cases at our Medical School is on diagnosis and it appears that, in our setting, the skills learnt while analyzing these diagnostic problems are not automatically transferred to solving of treatment problems. This finding is in line with those of Norman (1988), who found no evidence that generic problem solving skills were enhanced through PBL.

Throughout their course, students are tested using a limited number of assessment methods which include true/false questions linked to a case and which do not include short questions. The results for the short answers may be particularly poor (with an average mark of under 50%) because students have no practice in this skill. Also, the true/false questions were not negatively marked and this may have inflated the results for

these questions above a realistic level. (Negative marking was not used because responses were linked to a confidence rating and students were asked to complete all the questions, giving a confidence rating of 1 for answers they did not know.)

Of the short answer questions, the worst answered was a dosage calculation question (average 5%.) The question, which was deemed to be testing the ability to integrate knowledge, required that students retrieve dosing information from a dense package insert, and explain the steps to appropriate dosing. There may be a number of reasons contributing to the particularly poor answering of this question. First, this kind of question was new to students and they may not have fully understood what was required of them. Second, while package inserts have been available as an information source throughout their studies, students have not been guided through them explicitly. Incorrect responses included some where students retrieved inappropriate information and used this in an attempt to calculate a dose, possibly indicating a medical literacy problem. Third, students had difficulty calculating appropriate drug volumes, suggesting that numeracy skills were weak.

Even for the best answered short question (counselling messages in angina treatment), students attained an average mark of only 41%. The question also included a package insert, but this was less detailed and students may have learned appropriate patient information elsewhere. The best answered true/false questions related to important safety information given in an insulin package insert. This topic had been extensively covered in an introductory lecture, and was deemed to be testing lower level cognitive skills of

knowledge and comprehension. The difference in results for these questions, which all required some ability to make sense of information from a package insert, suggested that students needed guidance negotiating this information source.

The worst answered true/false questions were those which required an understanding of how to read graphs. Students fared better in this if they had seen the graph previously during lectures, as was the case with the theophylline graph where they scored an average mark of over 50%. However, it appeared they were not able to transfer this skill to interpreting a graph *de novo* as evidenced in the anticonvulsant question. This finding indicates that students needed help understanding graphical representations, and is in keeping with that of a study in another problem-based setting where students least liked questions containing visual representations such as tables or charts (Marin-Campos et al., 2004).

Considering students' confidence in relation to their responses, results were disturbing for one part of the worst answered question. Here students who answered incorrectly had a higher confidence rating (statistically significant) than students who gave the right answer. These findings raise the spectre of the 'unconsciously incompetent' person, whose overconfidence may result in the performing of tasks beyond his/her capability. Confidence must be balanced with knowledge of personal limitations and abilities to prevent serious repercussions. (Stewart et al., 2000). Interestingly, in the study of Burch et al. (2005), students were also more confident in their prescribing abilities than was reflected by their performance scores.

Interviews

The findings from this qualitative part of the study support to an extent the quantitative data and add depth, perspective and interest.

With an appropriate prescription given for only 4 of a possible 40 cases, findings about prescriber competence from the 10 students interviewed were also disappointing. Only one student offered patient counselling information in this context driven situation, despite the fact that patient counselling was a positive area in the test. More encouraging is the finding that eight out of ten students suggested an appropriate source of prescribing information, the South African Medicines Formulary (Division of Pharmacology, UCT, 2003). Prescribers willing to consult such a reference to assist in drug selection are more likely to make an appropriate choice. If students had been allowed to consult a reference during the interview, they might have given more appropriate prescriptions. This finding might be a result of PBL, where information seeking skills are emphasized.

All students considered drug efficacy in making their prescribing decisions, but they differed as to where their choice of drugs originated. Some thought of drugs they had used themselves, some remembered drugs mentioned in a lecture or by a consultant during a clinic visit. Rational prescribing requires setting a therapeutic goal and choosing the treatment best suited to attaining that goal, taking into account the benefits of efficacy and patient suitability weighed against drug safety considerations and financial cost

(Denig et al.,2002). Nine students made decisions based on at least two of these considerations.

There seemed to be no correlation between the reasoning ability of an interviewee and either his/her test results or the median overall confidence rating given for true/false questions. The number of students interviewed was small, so this finding should not be considered representative of the whole class.

An analysis of the comments selected to highlight student mistakes and problems, keeping Bloom's taxonomy and the work on learning strategies in mind, allow interesting revelations about conceptions of learning and cognitive ability.

With reference to students' mistakes (Table 9),

- On the simplest level, one mistake occurred as a misunderstanding of the meaning of a word. It is always necessary to be aware of such problems of misinterpretation in a multilingual society.
- The mistaken giving of a drug belonging to the same category as penicillin, as an alternative for penicillin allergy, demonstrated a deficit in another student's knowledge. This particular mistake could have a life-or-death outcome in a practice situation. Possible remedies could include a greater focus on drumming critical knowledge into students' heads through emphasis and repetition, or through giving real life practical examples of the consequences of this kind of

mistake. This strategy would be supported by encouraging the habit of checking a decision with a written reference.

- The mistake as a result of polypharmacy (this term meaning the overprescription of drugs to treat problems where a lesser number of medicines would result in better management) shows a lack of analytical abilities. If the student concerned had broken the problem down to seek the cause of the problem, a more appropriate remedy could have been considered.
- The student who demonstrated a misunderstanding of disease transmission (coded as myths) would have benefited from a strategy focused on bringing students' prior knowledge to their attention so that it could be compared with the new knowledge being offered and errors in reasoning rectified.

The remaining categories all reflect an error in the ability to evaluate information and make appropriate decisions. For example one student was aware of the drugs that should be chosen to control persistent asthma. However, she chose an alternative drug usually reserved for second-line use and falling into disuse as a result of safety concerns, out of concern for side effects with the standard treatment, although evidence does not support her concerns. When the test used to assess the students abilities is considered (Annexure 1), only 3% of the questions were deemed as testing evaluation skills (Table 5). When so much of prescribing involves decision-making and the evaluation of benefit and risks associated with a particular treatment, it is clear that our assessment strategies should focus more on this higher level cognitive function if these skills are to be developed.

Turning our attention to the problems highlighted by students (Table 10), comments reveal something of the students' conception of learning itself. Starting with Blooms' Taxonomy of Affect, the comment relating to 'lack of focus on treatment in PBL cases' shows a student who has realized that in order for learning to take place in a particular area, attention must be paid to that area. The students' recognizing a gap between theory and practice also demonstrates that they have operated at Blooms' lowest affective level of reception, perceiving the difference between what they can do and what they need to do. The comments relating to insufficient coverage and to a gap in knowledge related to dosage both reveal an understanding of learning as a body of knowledge that has to be transferred from teacher to learner, a conception associated with a surface approach to learning. These views show an understanding of cognitive ability that is limited to recall. The comment describing the category "Basic science lack" reveals a student struggling with the cognitive demands of comprehension. The student whose comment describes the "prescribing strategy gap" category shows some understanding of the evaluative skills required in order to prescribe competently.

More is exposed about student conceptions in the phenomenographic part of the analysis. My approach to the analysis of the transcripts differed from that of Denig et al (2002). They categorise student reasoning abilities according to the number of drugs that are considered in making a prescribing decision. Within each of these categories, students are rated further according to the number of relevant aspects that are considered. Although in table 12, I have made reference to the number of drugs considered and the number of relevant aspects raised, these have not been the defining criteria of my categorization.

However it must be said that as the level of the category of description increases according to my classification, so, in general, do the number of drugs and relevant aspects considered. The outcome space I have described in Table 12 shows the prescribing decision involving an increasingly complex reasoning process. In addition, as the conception develops, an understanding of the role of the patient appears to change. In the first category, the student was interested in giving an inhaler to induce bronchodilation in the smooth muscle of the lung, her consideration of the patient limited to the level of the organ concerned. Students in the second category were interested in the patient with regard to what examination or information about symptoms would reveal about level of disease. Students in category III had developed an understanding that a drug could be effective and suitable or unsuitable depending on patient characteristics, some of which are alterable (e.g. inhaler technique can be improved). The understanding shown by the student in the fourth category is of the patient as an individual attached to a context (in this case a work situation which might exacerbate asthma symptoms). In the final level the conception of the patient in relation to the prescribing process has again changed. The student falling in this category has recognized that optimum prescribing is also dependant on the ability and motivation of the patient to follow the prescribing decision. This student sees the need to deal with the asthma patient's acute problems, to give the patient time to settle, and then to discuss the patient's wishes when she is able to listen and communicate her needs effectively and when she is able to understand the rationale behind the prescribing decision.

The conceptions of prescribing exposed after analysis of the otitis media case material (Table 13) differ from those revealed through the asthma prescribing case. Again the levels of conception show an increasing complexity at the level of the disease process, this process involving more stages because selection of an effective treatment requires an understanding that an underlying cause must be targeted. Level IV for the otitis media description can be compared with level II for the asthma case. For the otitis media example, students did not display the higher levels of conception seen with the asthma question, perhaps because the focus of their cognitive efforts was around selection of an effective drug. Viewing these findings from the perspective of the philosophy of an object as being inseparable from its contextual field, underpinning Gestalt theory and phenomenography, it is not surprising that two different prescribing situations yield two differing outcomes. I would expect that data collected from further contexts would each time tell a different story about what students understand of the prescribing process and that each description would contribute more to our understanding of what it is that they conceive.

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Intervention

Know your learners

The successful finding of improved confidence among students in their prescribing abilities following our intervention may be explained in part by the fact that, owing to the data, both qualitative and quantitative, that we had collected, we "knew our learners", (one of Angelo's Principles for improving higher learning, (Angelo, 1993), and we had a

clear picture of where their strengths and weaknesses lay. We used this knowledge to develop our intervention.

Prior knowledge

We were able to pitch our intervention at the level that most suited this particular class. This corresponds with Angelo's fourth principle, that "to be remembered, new information must be meaningfully connected to prior knowledge, and it must first be remembered in order to be learned." Thanks to the extensive information gathered, we were able to start with what we knew students were comfortable with and to build from there. Entwistle's findings (Entwistle & Ramsden, 1983)also indicate the importance of pitching the lecture at an appropriate level, particularly for the science subjects, if a deep approach to learning is to be encouraged. It will be important that we take the time to find out exactly what our learners know and to bring students' prior knowledge, both conceptions and misconceptions, to the forefront of their awareness in future learning strategies developed from this intervention.

Focus on the Big Picture

Our feeling was that while students had an idea of how specific drugs worked, they lacked a picture of how these discrete bits of knowledge fitted together. We talked of needing to provide 'hooks to hang things from'. Our large group sessions focused on explaining and providing organograms to help students see how items of knowledge related together. This focus on overviews of related concepts served an integrative purpose, offering students the opportunity to engage in a cognitive activity ranking high

on Bloom's Taxonomy for educational endeavour (Bloom, 1956). Students who are able to see relations between elements of their understanding in a subject and who are aware of how that understanding and those relationships can be applied in new contexts have a higher quality learning outcome than those who are not (Prosser & Trigwell, 1999). A teaching strategy focused away from rote learning and toward higher level cognitive function supports a shift in students' efforts in this direction too.

This focus on overview can also be considered in terms of Gestalt theory as an exercise in whole-making, the results of this reorganizing of material being learning and change.(Kirchner,2000).

Developing perspective

We felt Angelo's second principle that "learning requires...awareness of the importance of what is to be learnt" (Angelo, 1993) was also relevant here. Angelo claims that students find it difficult to sort out what is of pivotal importance from what is merely a finer point. The large group sessions were designed to highlight key information and to help students put things in perspective.

Getting beneath the surface learning

Particularly in the dosage calculation question and answer session we found evidence to support Angelo's fifth principle (Angelo, 1993) that "unlearning what is already known is often more difficult than learning new information." Many students had learnt a formula to work out the volume required of medication of a particular concentration. They

seemed to have little understanding of the arithmetic reasoning behind this formula. It was first necessary to have students dispense with this surface learned knowledge or at least to set this aside so that they could go back to something that was understood. We aimed then to build on this knowledge so that students could follow the arithmetical steps, again bringing us back to the importance of connecting to prior knowledge which is stressed in Angelo's fourth Principle (Angelo, 1993).

Starting on the right track

The small group sessions afforded students the opportunity to engage with the P-drug approach to solve paper cases. The use of South African Standard Treatment Guidelines (Department of Health, 1998), kept the focus of problems relevant to the needs of the region as has been identified as key to the development of a Doctor for Africa (WHO Regional Office for Africa, 1995). It also gave students the chance to practise using a treatment guideline to support their prescribing decision and to reflect upon the utility of these in the prescribing process. This exposure also allowed some critical evaluation of the recommendations, a step which has been identified as key to the use by practitioners of guidelines in their practice. In addition to associating a treatment with a particular disease, the student focuses on the *process* of selecting an appropriate treatment. Such teaching strategies develop metacognitive skills, and is associated with an increase in the depth of learning and with the development of learner autonomy (Sadler-Smith 2001 *loc.cit* Coffield et al., 2004).

Need for support

In particular, we believe our findings reflect the principle that "to be most effective, teachers need to balance levels of intellectual challenge and instructional support." Angelo uses the metaphor of scaffolding to describe the student's need for support. The less the student has a foundation in a subject, the more support and structure is required. Entwhistle's findings regarding the association between the acquisition of sufficient prior knowledge and information related to a task and of deep learning among science students also highlights the importance of early support. (Entwistle & Ramsden, 1983)

Apter's Theory of Motivational Styles (Coffield *et al*, 2004) is relevant here because according to this theory, two of the main reasons for switching between motivational styles are frustration and satiation. When such 'reversals' are prevented by attending timeously to causes of frustration, for example, by diagnosing gaps in understanding and by developing strategies to remedy these, motivation is maintained and learning can continue. I believe that our research helped us find key weaknesses in the understanding of our students allowing us to design the most appropriate intervention that would allow learners to build understanding in these areas. Variation of teaching strategies, with a movement toward more learner-centred methods, helped prevent a switch in motivational styles as a result of boredom. This gradual shift in the balance between instructional support and intellectual challenge from predominant support to increased challenge allows learner autonomy to build, and, as our findings show, for prescriber confidence to grow.

Post-intervention test

My inability to collect a representative sample of data from which to draw conclusions and make comparisons was a disappointment. A poor response rate is a disadvantage in the questionnaire method (Gillham. B., 2000) and I now feel that I was fortunate to get sufficient number of responders for the pre-intervention test. Fortunately, employing a mix of methods meant that other data was sufficiently rich for answers to my research questions to be found. This experience also helped me appreciate and focus more on the qualitative research component of the study.

Evaluation

Overall, the course evaluation was positive and students had a sense that their abilities had improved. Strengths of the course, highlighted by students in their evaluation questionnaire, compare with several of the qualities emphasised in Chickering and Gamson's *Seven Principles for Good Practice in Undergraduate Education* (1987). This list, based on fifty years of higher education research, formed the basis for the development of faculty and institutional inventories which have helped higher education institutions examine and improve their teaching (Johnson Foundation 1989). According to these documents, the encouragement of student-faculty contact, of co-operation among students and of active learning; prompt feedback; spending time working on a task; communicating high expectations and the promotion of diverse talents and ways of learning all foster good learning.

Despite the disadvantage that the initial confidence rating was undertaken retrospectively and thus was subject to recall bias, students reported an improvement in confidence for each of the prescribing abilities listed. There is strong evidence that a student's confidence in his/her ability to perform a task successfully provides the motivation to undertake the action (Carlisle, 2000). Stewart et al. (2000) reported that having confidence allowed British house officers to continue to perform a task if they were initially unsuccessful. Confidence thus seems to provide the impetus to keep trying, leading to the development of competence as a result of practice and reflection.

Further developments

In Africa, the lack of technical support for the appropriate use of essential medicines and the benefits of a teaching approach which increases rational prescribing has been recognized (Barnes, 1997). Likewise the importance of student feedback in curriculum design is well recognized (Huppatz, 1996). The findings of this study have informed the development, in 2005, of a therapeutics module within a new foundation theme where basic sciences are stressed and which will be assessed.

Students participate in this theme at the start of their medical studies. We see this time as an opportunity to initiate a supportive relationship between the student and the therapeutics department. Students are offered structured sessions initially, followed gradually throughout this theme with tasks requiring more learner independence. By offering plenty of initial structure we hope to build the student confidence and trust that comes from firm foundation knowledge, and that this will allow students to proceed in

their learning following a deep approach. By gradually removing this "scaffolding" we hope that students will move towards independence without losing confidence.

In addition to our input in the Foundation Theme, this study has also led to the provision of additional prescribing exercises and opportunities for students to practice caregiver-patient interactions using the P-drug approach throughout the course. Such learning opportunities afford our students the opportunity to develop their conception of the prescribing process and to elaborate their understanding and ability so that they can develop from confident learners to competent prescribers.

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Table 1
Categories of Bloom's Taxonomy Domains

Cognitive ***Knowledge***	**Affective** ***Attitude***	**Psychomotor** ***Skills***
Recall data	Receive (awareness)	Imitate
Understand	Respond (react)	Manipulate (follow instructions)
Apply (use)	Value (understand and act)	Develop precision
Analyse structure/elements	Organise personal value system	Articulate (combine, integrate related skills)
Synthesize (create/build)	Internalise value system (adopt behaviour)	Naturalise(automate, become expert)
Evaluate (assess, judge in relational terms)		

Table 2 **Vermunt's learning styles with illustrations of their components**

	Meaning-directed	**Application-directed**	**Reproduction-directed**	**Undirected**
Cognitive processing	Look for relationships between key concepts/theories: build an overview	Relate topics to everyday experience: look for concrete examples and uses	Select main points to retain	Find study difficult; read and re-read
Learning orientation	Self-improvement and enrichment	Vocational or 'real world' outcomes	Prove competence by getting good marks	Ambivalent; insecure
Affective orientation	Intrinsic interest and pleasure	Interested in practical details	Put in time and effort; afraid of forgetting	Lack confidence; fear of failure
Mental model of learning	Dialogue with experts stimulates thinking and engagement with subject through exchange of views	Learn in order to use knowledge	Look for structure in teaching and texts to help take in knowledge and pass examinations. Do not value critical processing or peer discussion	Want teachers to do more; seek peer support
Regulation of learning	Self-guided by interest and their own questions; diagnose and correct poor understanding	Think of problems and examples to test understanding, especially of abstract concepts	Use objectives to check understanding; self-test; rehearse	Not adaptive

Table 3 **Possible motivational style relationships in the four experiential domains of Apter's reversal theory of motivational styles**

Need **Style**	Achievement Serious	Means-ends domain ⟷	Fun playful
Need **Style**	Fitting in Conforming	Rules domain ⟷	Freedom Challenging
Need **Style**	Power Competitive	Transactions domain ⟷	Love Affectionate
Need **Style**	Individuation Self-orientated	Relationships domain ⟷	Transcendence Other-orientated

Table 4 Topics and skills tested in the pre-intervention therapeutics test

Skill	Skill description	Topics and Material
1	Selecting appropriate treatment	-malaria -post-natal depression and FDA-pregnancy categories -Type 2 diabetes
2	Using guidelines to guide prescribing	-WHO Medical Eligibility Criteria for Starting Contraceptive Methods - South African Dyslipidaemia Clinical Guideline
3	Medical literacy: understanding package inserts and the South African Medicines Formulary	-antiretrovirals: SAMF excerpt -dosage calculations: cefotaxime package insert -insulin
4	Counselling	-missed contraceptive pill -malaria prophylaxis
5	Critical assessment of company literature	-inhaled corticosteroids: advertisement
6	Detection, monitoring and treating drug-related adverse reactions	-adrenaline -aminoglycoside antibiotics -neostigmine -insulin -metoclopramide
7	Interpretation of drug levels/ monitoring and using these to guide prescribing	-valproate -theophylline
8	Dosage calculation	- cefotaxime package insert
9	Avoiding /combating polypharmacy	-drug interaction: ibuprofen with cardiac failure medication

Table 5 Analysis of test questions according to Bloom's taxonomy

Bloom Domain	T/F%	short answer %	Overall %
knowledge	31	18	25
comprehension	12	44	22
application	42	18	31
analysis	10	0	6
synthesis	0	20	7
evaluation	5	0	3

Table 6 Paper cases discussed in student in-depth interviews

A	What prescription would you give to an asthmatic patient who presents for a repeat prescription of her salbutamol inhaler. She appears a little wheezy and asks if you will please prescribe two salbutamol inhalers this time as she ran out of her inhaler two weeks ago and had to buy an extra one at her own expense
B	A child of two is brought to see you by her mother. After taking a thorough history and on examination you diagnose otitis media. What do you prescribe?
C	What do you prescribe for Mrs Karlsen, 73, who comes for a repeat of her simvastatin and hydrochlorothiazide script. Her cholesterol is well controlled on this treatment. She mentions that her legs are aching and she gets weak and stiff easily when she does her walking programme. She thinks this is probably due to the after-effects of the sinus infection she has had recently. She had been treated with clarithromycin
D	Mrs De Beer is asking for something for her osteoarthritic knee which is giving her pain after a day spent digging in the garden. She is 76, and takes a diuretic (furosemide) and an ACE inhibitor (captopril) for her mild heart failure. What would you prescribe?

Table 7a Summary of student test results: short answers

Skill number	Skill description	Topic	Bloom Domain	Result (Average %)
1	Selecting appropriate treatment	antithrombotic action of aspirin	application	20%
		Case management peptic ulcer patient	synthesis	28%
3	Medical literacy	antiretroviral combination therapy	comprehension	18%
4	Counselling	glyceryl trinitrate treatment information	knowledge and application	41%
6	Adverse drug reactions	penicillin anaphylaxis	knowledge and comprehension	26%
		neostigmine antidote for muscle relaxant toxicity	comprehension	13%
		aminoglycoside nephrotoxicity	knowledge and comprehension	15%
8	Dosage calculation	Cefotaxime package insert	synthesis	5%

Table 7b Summary of student test results: true/false
* = top result ** = bottom result

Skill number	Skill description	Topic of Problem	Bloom Domain (number of questions per problem relating to each Bloom Domain)	Result (Average %)	Confidence rating (median)
1	Selecting appropriate treatment	Type 2 diabetes treatment	knowledge (1) application (2) evaluation (2)	74%	8
		Post-natal depression/ pregnancy categories	knowledge (1) comprehension(1) application (2) evaluation (1)	62%	3
2	Using guidelines to guide prescribing	Contraceptive eligibility criteria	application (4) analysis (1)	73%	8
		Hypercholesterolaemia treatment	knowledge (1) application(2) evaluation (2)	67%	5
3	Medical literacy	Insulin	knowledge (4) comprehension (1)	84%*	7
4	Counselling	Malaria prophylaxis	knowledge (2) comprehension (2) application (1)	73%	7
		Missed pill	knowledge (1) application (4)	74%	8
5	Critical assessment of company literature	Inhaled steroid advert	knowledge (1) comprehension (1) application (1) analysis (2)	64%	7
6	Adverse drug reactions	Dystonic reaction with metoclopramide	comprehension (2) application (3)	62%	4
7	Interpretation of drug levels	Theophylline graph	knowledge (3) application (1) analysis (1)	61%	6.5
		Valproate graph	knowledge (2) application (2) analysis (1)	48%**	5
9	Avoiding/ combating polypharmacy	Drug-interaction ibuprofen with cardiac failure medication	knowledge (1) application (4)	81%	6

Table 7c **Comparison of mean confidence rating for students answering correctly and incorrectly for selected true/false questions**

Topic	Reason for analysis	Overall median confidence rating	Mean (n) confidence rating			
			Answer Correct	Answer Incorrect	T Statistic	P-value
Insulin	Best result	7				
Part 1	(84%)		6.7(111)	3.5(6)	2.2665	0.0253
Part 2			7.9 (101)	4.6(16)	4.0323	0.0001
Part 3			5.2 (104)	5.5 (13)	0.3641	0.7165
Part 4			6.2 (75)	5.4 (43)	1.1427	0.2555
Part 5			7.1 (100)	5.5 (16)	1.7171	0.0887
Valproate	Worst result	5				
Part 1	(48%)		6.7 (84)	5.1 (31)	2.3062	0.0229
Part 2			5.1 (43)	4.8 (71)	0.4391	0.6615
Part 3			5.1 (67)	6.0 (48)	1.3588	0.1769
Part 4			2.7 (42)	4 (65)	2.3061	0.0231
Part 5			5.1 (47)	4.5 (66)	0.9965	0.3212

Table 8 Profile of the key themes identified in interview transcripts

Parent node	Child node	Number of students	No of passages	Number of paragraphs	Examples of student comments
Coping strategy	Information strategy	9	20	38	I'm really trying to think sometimes with drugs sometimes they just go and escape my mind…can I just see something?" (looks in SAMF)
	Referral	2	2	2	if there is no improvement after trial of antibiotics, I would refer the patient to the ENT specialist.
	View of own reasoning	1	1	1	I am a slow thinker myself
Reasons for actions	Treatment choice personal	1	1	1	OK well um for salbutamol if that works for her I would prescribe it but um I'm thinking if because I use an inhaler so I know that it should last
Diagnosis	Causative organisms	3	4	5	I think it's generally a staph the causative bacteria
	Diagnostic tests	5	8	8	I'll even consider taking maybe a some specimen and then um let's just look here ok specimen for laboratory as well as for microscopy but the organism is considered.properly
	Laboratory monitoring	2	2	4	When you give the statin you'd have to check on the urea levels
	Level of disease	9	16	18	she's using too much of the salbutamol it could mean that she's to go a step higher
	Possible disease causes	6	11	11	I don't know the side effects if it could truly be the side effects of this medication or that her cholesterol is probably getting worse and there is narrowing of vessels
	Rules out disease causes	1	1	1	I don't really see the relationship between her getting tired the legs aching and that with the sinus infection
Holistic features	Holistic care	4	7	13	another thing when we use these things I think we have to look at the patient and the drug whether there are other diseases and the side effects
	Inhaler technique	3	3	7	whether the patient can use the inhaler very well. Sometimes when we check it out they can not use the inhaler….. and in the case where the patient can not then I'll provide a spacer
	Non-drug	5	6	12	ja, wow, with me I just know one thing is if it perforates to clean the ears
	Non-drug non-disease	1	2	2	I'll try to find out maybe there's an indication whether she was whether the patient was developing the , her condition was an increaser(precursor) for the patient developing an aggravated effect, so maybe we could just take the patient out of that environment
	Patient circumstances	1	1	1	I would think(to come up with is this thing) First thing you've got to know your patient and then we'll know the socioeconomics of the patient whether they're working or not working
	Patient counseling	1	2	2	ry to explain those things to the patient that she will if the patient experience those that the patient will know it's because of her inhaler.
Drug treatment	Acute treatment	3	3	3	if the patient is acutely um respiratorily challenged I would give her er I would nebulise her
	Appropriate treatment	3	8	12	and then you probably would really want to start her on a corticosteroid inhaler as well.
	Alternate treatment	1	1	1	if she's allergic to penicillin I'd give her erythromycin
	Change drug	3	5	17	um, I'd change her heart medication because I know that diuretics could end up with joint problems

Parent node	Child node	Number of students	No of passages	Number of paragraphs	Student comment
	Consider withholding drug	3	5	7	I can't stop this, like I can't stop her hypertension and you know, maybe I can stop this for a while then after I find out the circumstances that (it's used).... then I can give an alternative treatment. Ja, that's probably what I'd do
	Drug indication	10	44	39	and that's a simvastatin is used for cholesterol levels
	Drug name or class	10	43	46	I'd give her er a beta-2-stimulant which is the salbutamol
	Mechanism of action	1	1	9	because they are beta-2-stimulants and they will they will work on the smooth muscle and will cause bronchodilation
	Need for drug	7	11	14	I would have to,yes it says here that the cholesterol is well controlled on this treatment I would just have to write it again. She must have it.
	Order of drugs	1	1	1	er, how to use it, tell her to use it, there's a proper....of using it that it has to go in with inspiration and she can use her steroids I mean the reliever one the salbutamol earlier on perhaps wait 20 minutes for the alveolus to open or something like that and then maybe 20 to 30 minutes ..I'd take the steroids
	Pharmacokinetic	2	2	4	Ok just let it excrete
	Treatment based on efficacy	6	13	14	I'd give her penicillin because it's the strongest that's what I think
Suitability	Allergy	4	4	4	is the child allergic to anything?
	Drug availability	1	1	1	patient is the reason is it available in most of the places I mean can the patient access the drug very easily
	Treatment based on suitability	7	11	20	The child is 2 years old, so I'm thinking now, ok... I'm thinking um, I wouldn't want this to complicate because they very easily and quickly complicated to meningitis
	Drug interaction	8	14	24	but the problem with NSAID is they are going to reduce treatment effect
Financial cost	Affordability	2	2	2	is the drug cheap or expensive within the means can the patient obtain afford to buy the drug.
Safety	Drug cause or side effect	10	26	39	the patient might experience some palpitations those things, er muscle tremors those things
	Treatment based on safety	7	16	39	this is another lady um her cholesterol is fine so um I can just like just make sure that these symptoms she's having is not due to that er to the simvastatin um
Dose	Dosage form	10	21	38	it's an inhaler
	Dosage frequency	4	5	10	then she uses this one intermittently
	Dosage duration	2	3	3	ja, it's penicillin um I'm not sure of the dosages, but I think it would be penicillin for a week.
Confidence		10	10	15	honestly speaking. Um I would be really scared I would be worried if I were the patient that I was prescribing for someone right now you know

Table 8 continued Profile of the key themes identified in interview transcripts

Table 9 Student mistakes made while responding to paper case during interviews

Node	Profile coding			Example
	Number of students' documents coded	Number of paragraphs coded	Number of passages coded	
Incorrect alternate drug choice	1	1	1	Amoxicillin given as alternative in patient with penicillin allergy
Inappropriate drug for level of disease	2	2	2	Theophylline chosen to add to salbutamol in uncontrolled asthma
Unnecessary caution contraindication	1	2	1	Decision not to give inhaled steroids to asthma patient and to instead give theophylline because patient was believed to be young (no age information given in case)
Polypharmacy	1	1	1	Prescribing NSAID to treat stiffness associated with antibiotic-induced myalgia in patient taking a statin
Myths	1	1	1	Advice to keep patient indoors to prevent contracting additional disease while patient has otitis media
Inappropriate action	2	3	2	Prescribing drugs and waiting for patient to complain before taking a possible drug interaction into account
Incorrect drug class	3	3	3	Steroids to treat osteoarthritic knee
Side effect misinterpreted	1	1	1	Aching understood as itching

Table 10 Student's perception of problems contributing to student lack of confidence

Node	Profile coding			Student comment
	Number of students' documents coded	Number of paragraphs coded	Number of passages coded	
Insufficient coverage	3	3	3	"Obviously we haven't done as much pharm as we should"
Lack of focus on treatment in PBL cases	3	3	3	" by the time you get to treatment it's a quick add-on"
Basic science lack	3	3	6	"I think also what we needed was like the basic back to receptors, back to physiology how does this drug work so you know, I mean once you know the physiology the side effects comes easy instead of trying to learn a list and not remembering half the time what it interacts with you know
Gap theory and practice	2	10	2	"We go to hospitals in this clinical methods course and its actually necessary for you to know basic information about antibiotics and analgesics and most of our cases we did "
Prescribing strategy gap	5	15	5	"like it's very different when you've got like one drug and you've got another drug and you've actually got to prescribe like"
Dosage gap	4	5	5	"if you've (a treatment) for example, I would know sometimes drug I would know it's used for what but the thing is usually we don't address…dose, we don't know much about dose because I mean we don't usually, we're not usually taught the dose so .. I think the more lectures will be, will have to be on the dose, we have to know the dose"

Table 11 Summary of student interviews

Test result	Median confidence score (T/F questions)	Appropriate treatment?	Important information?	Information strategy	Treatment decision based on:			
					Efficacy	Safety	Suitability	Cost
64%	missing	Case 1 and 2× Case 3 and 4✓	×	South African Medicines Formulary (SAMF)	✓	Case 1,3 ✓	Case 4 ✓	×
60%	6	All cases ×	×	×	✓	×	Case 2, 4✓	×
56%	7.5	All cases ×	×	SAMF Essential Drugs List (*EDL*)	✓	Case 1, 3 ✓	Case 4✓	×
54%	10	Case 1✓ Case 2 , 3, 4 ×	✓ Case 1 safety	SAMF	✓	Case 2 ✓	Case 4✓	×
49%	4.5	All cases ×	×	SAMF	✓	×	×	×
46%	6.5	All cases ×	×	SAMF	✓	Case 3 ✓	Case 3, 4✓	×
43%	6	All cases ×	×	SAMF	✓	All cases ✓	Case 1, 4 ✓	Case 1✓
41%	10	Case 1 ✓ Case 2, 3, 4 ×	×	SAMF	✓	Case 3 ✓	Case 2, 3, 4✓	Case 4✓
39%	1	All Cases ×	×	SAMF internet	✓	Case3✓	Case 2, 4 ✓	×
33%	4.5	All cases ×	×	×	✓	Case 3, 4✓	Case 2 ✓	×

Table 12 Outcome Space for Student Conceptions of Prescribing for a patient with uncontrolled asthma

I Sees prescribing as giving medicines to treat symptoms (1 student) Student 10: 1 drug no aspects
II Sees prescribing as choosing medicines to treat level of disease (1 students) Student 3: 2 drugs, 1 relevant aspects Student 8: 2 drugs, 2 relevant aspects
III Sees prescribing as choosing suitable medicines to treat level of disease (5 students) **a *Negative aspects considered*** (2 students) Student 6: 2 drugs, 4 relevant aspects Student 7: 3 drugs, 2 relevant aspects **b *Making sure patient is able to take medicine*** (2 students) Student 9: 1 drug, 1 relevant aspects Student 4: 3 drugs, 2 relevant aspects **ab *Both considered*** (1 student) Student 5: 2 drugs, 4 relevant aspects
IV Sees prescribing as choosing suitable treatment to treat cause Student 2: 2 drugs, 5 relevant aspects
V Sees prescribing as involving patient in the management of her disease Student 1: 2 drugs, 4 relevant aspects

Table 13 Outcome Space for Student Conceptions of Prescribing for a patient with otitis media

I Sees prescribing as treating the disease (2 students) Student 1: "ear drops that's what most ENT people use as treatment for middle ear infection" Students 9: "use antibiotics, analgesics and grommets"
II Sees prescribing as preventing complications (1 student) Student 10: "I'd give her penicillin because it's the strongest that's what I think and in case and so it doesn't become suppurative or chronic or doesn't erode into her meninges or cause complications..."
III Sees prescribing as killing causative organism (4 students) Student 8: "I'll suspect a common organism... I could take a sample and send it for testing" Student 2: "..Specimen for laboratory as well as microscopy but the organism is considered properly" Student 3: "One of the common ones is Augmentin® and I'm not sure whether that covers.." Student 7: "depends on the organism"
IV Sees prescribing as selecting a drug to kill causative organism in relation to level of disease Student 6: "using the 'scope you can just check for the membrane whether it's perforated or not perforated Student 4: "if it's otitis media and it's not chronic then the ear won't be perforated" Student 5: "if the ear is oozing, if there is no discharge coming out of the ear, well I would give her antibiotics to cover the organisms...ask the mother to mop the ear..."

Figure 1 **Diagram to show presage-process-product model of student learning**

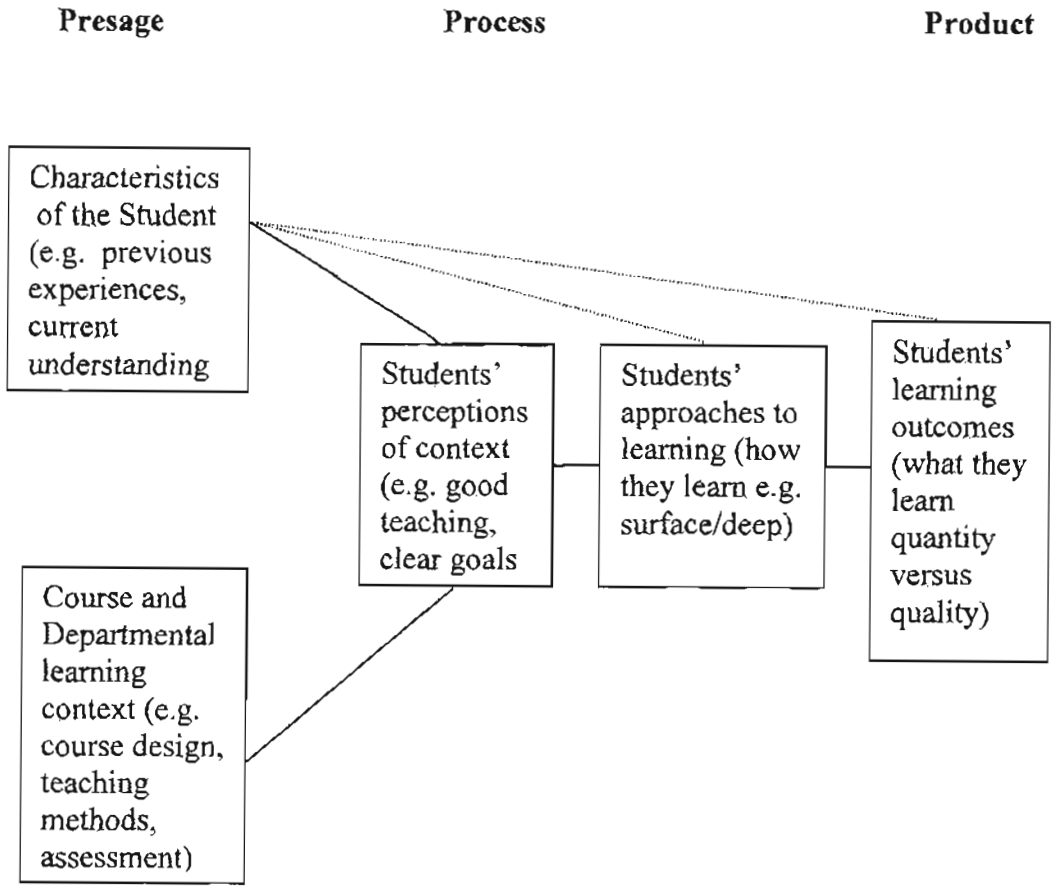
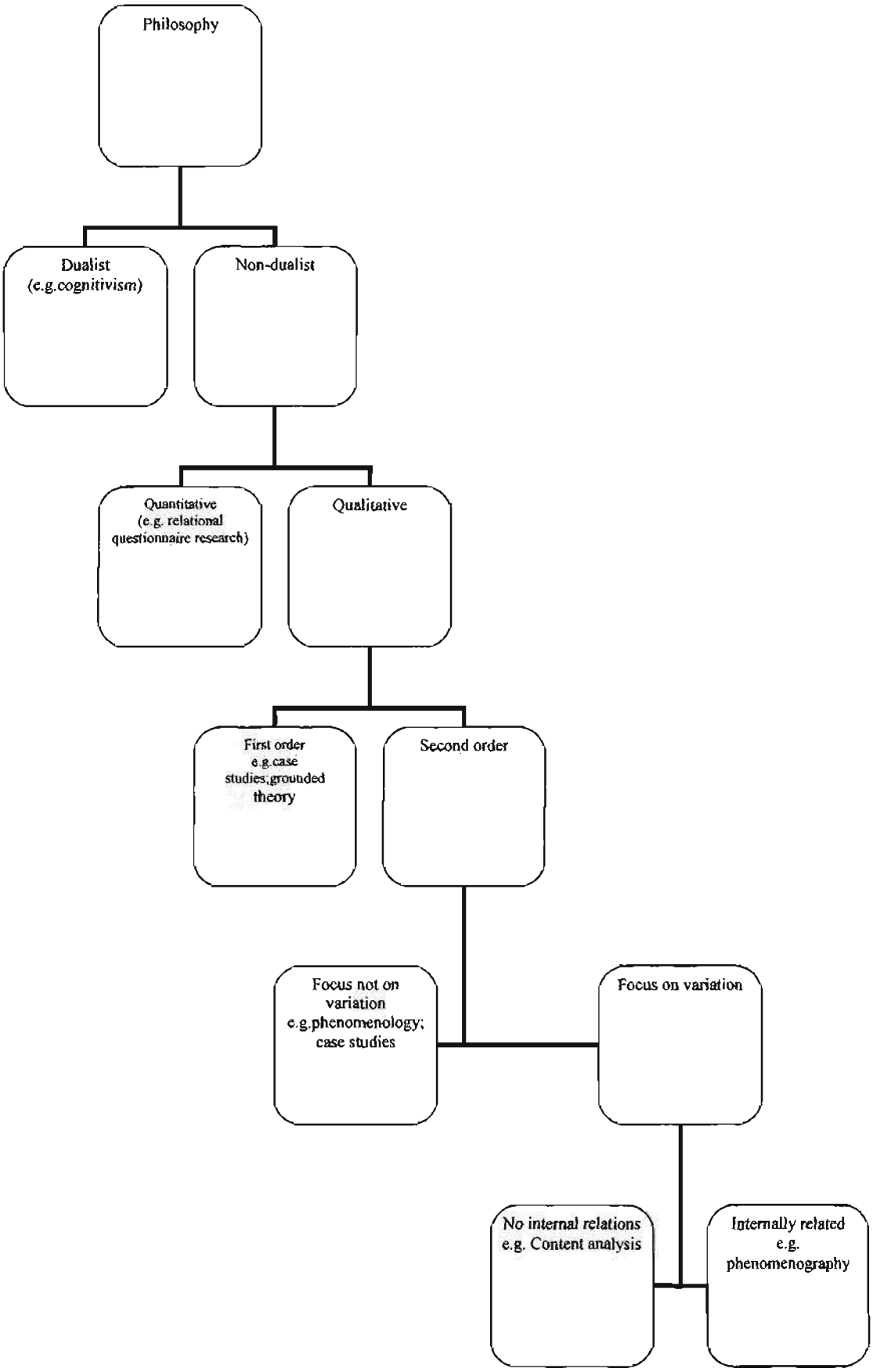


Figure 2 **Trigwell's Organogram to show the relationship between different research traditions**



APPENDIX I Pre-and Post-Intervention Questionnaire

Questions 1 – 12 are True or False questions. Beneath each question is a box with T (true) or F (false) marked as well as numbers 1 -10.

1. Indicate by circling either **T** or **F** whether you think the answer is true or false.
2. Rate how confident you feel that your answer is correct by circling **one** of the nos. 1 – 10 where **1 is least** confident (a guess) and **10 is most** confident (absolutely convinced).

1. <u>Please refer to advert Question 1 in the Appendix.</u>

a. Growth retardation may be an adverse effect of high dose inhaled corticosteroids in children.

T	F		1	2	3	4	5	6	7	8	9	10

b. The advert states that the fluticasone product does not impair growth.

T	F		1	2	3	4	5	6	7	8	9	10

c. The advert implies that the advertised product allows or encourages normal growth in children, but does not state this explicitly.

T	F		1	2	3	4	5	6	7	8	9	10

d. The advert claims that fluticasone is more potent than its competitor budesonide.

T	F		1	2	3	4	5	6	7	8	9	10

e. Fluticasone can be given at half the daily microgram dose needed for the same effect with budesonide, so it is less likely to cause growth retardation for the same improvement in peak flow.

T	F		1	2	3	4	5	6	7	8	9	10

2. A family with a 3 year old child is planning a trip to one of the game reserves in rural Mozambique. They ask you advice regarding malaria prophylaxis. The father has heard from a friend that the drugs do not offer complete protection and make it difficult to diagnose malaria if they were to contract it. He is now uncertain what to do.

a. The family should be advised not to go to the area as malaria is particularly dangerous in children under 5 years.

T	F		1	2	3	4	5	6	7	8	9	10

b. Antimalarials are not totally effective and symptoms do tend to take longer to appear if a patient contracts malaria while taking prophylaxis, so the family should take precautions to avoid being bitten by mosquitoes.

T	F		1	2	3	4	5	6	7	8	9	10

c. In a patient who contracts malaria while taking appropriate malaria prophylaxis, the symptoms tend to be less severe at first and complications are retarded.

T	F		1	2	3	4	5	6	7	8	9	10

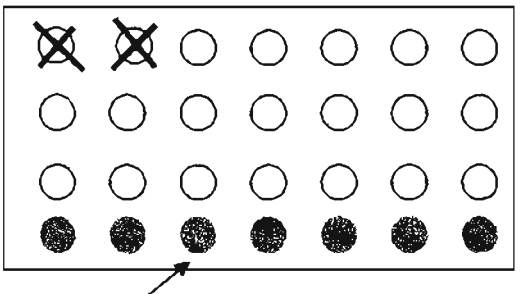
d. Mefloquine is contra-indicated in children less than 5 years old.

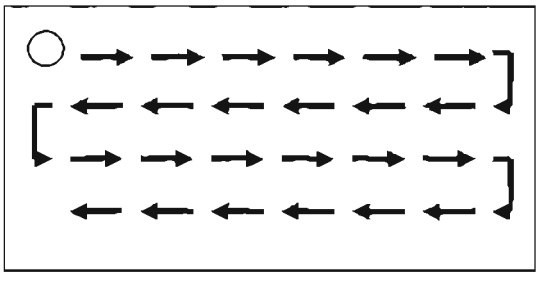
T	F		1	2	3	4	5	6	7	8	9	10

e. The family should be counseled to report flu-like symptoms which develop during their stay and for around two months afterwards.

T	F		1	2	3	4	5	6	7	8	9	10

3. Mrs Jacobs has brought one of her children to see you with a minor problem. While you are reassuring them that the condition is self-limiting and no intervention is necessary, she mentions "It's ok if I've started my pack of Femodene® a bit late, isn't it?" and takes the pack of contraceptives from her handbag to show you which pills she has missed. She took all the red tablets from the previous pack, then with all the worry of a sick child she forgot to start the white tablets from the new pack for two days. The omitted tablets are marked with crosses on the picture of the contraceptive pack.
The last time she had sex was last night.





Red tablets shaded

a. Mrs Jacobs may have ovulated.

T	F		1	2	3	4	5	6	7	8	9	10

b. Mrs Jacobs should be reassured that she is not at risk of contraceptive failure.

T	F		1	2	3	4	5	6	7	8	9	10

c. Mrs Jacobs should be offered emergency contraception to be started immediately.

T	F		1	2	3	4	5	6	7	8	9	10

d. The 7-day rule should be discussed with Mrs Jacobs.

T	F		1	2	3	4	5	6	7	8	9	10

e. The placebo tablets should be omitted from the end of Mrs Jacobs' new pack and she should start the active tablets of the new pack instead.

T	F		1	2	3	4	5	6	7	8	9	10

4. You are a student using these guidelines **(Question 4 in the Appendix)** to evaluate the contraceptive selection for 5 people you know.

a. Femodene® containing gestodene 75mcg and ethinyloestradiol 30mcg is a suitable contraceptive for a woman exclusively breastfeeding her 5 month old baby.

T	F		1	2	3	4	5	6	7	8	9	10

b. In a woman receiving the standard antituberculosis drug regimen of rifampicin, isoniazid, ethambutol and pyrazinamide the hormonal contraceptive method of choice is DMPA given every two months.

T	F		1	2	3	4	5	6	7	8	9	10

c. Marvelon® containing desogestrel and ethinyloestradiol is a suitable choice of contraceptive in a patient who suffers from migraine which is usually preceded by a feeling of pins and needles which spreads up from the fingers of one arm.

T	F		1	2	3	4	5	6	7	8	9	10

d. Microval® (levonorgestrel) is a suitable choice for a 38- year old patient who smokes.

T	F		1	2	3	4	5	6	7	8	9	10

e. The progesterone only pill is suitable in patients with hypertension.

T	F		1	2	3	4	5	6	7	8	9	10

5. Linda has been taking sertraline for postnatal depression for a year. She would like to try for a second baby now that her little boy has turned two. Sertraline has an FDA-assigned pregnancy category of C.

a. Insufficient adequate studies have been conducted in humans to give an indication of the risk of this drug to the human foetus.

T	F		1	2	3	4	5	6	7	8	9	10

b. Sertraline is a potential behavioural teratogen.

T	F		1	2	3	4	5	6	7	8	9	10

c. The risks involved in the use of sertraline in pregnant women clearly outweigh the potential benefits.

T	F		1	2	3	4	5	6	7	8	9	10

d. Once a patient has responded to antidepressant treatment, therapy should be continued for 6-12 months after a single episode to prevent relapse.

T	F		1	2	3	4	5	6	7	8	9	10

e. If Linda chooses to continue with her drug sertraline after her new baby is born she will not be able to breastfeed.

T	F		1	2	3	4	5	6	7	8	9	10

6. A woman aged 76 years is taking a diuretic (furosemide) and ACE inhibitor (captopril) to treat her heart failure. The weather is warm and after a day spent digging in the garden, she is feeling unwell, probably due to mild dehydration, and her osteoarthritic knee has become painful. She phones her pharmacy for some ibuprofen tablets, which she has seen advertised on television.

a. When diuretics are used with NSAIDS there is an increased risk of hospitalization for heart failure compared with taking diuretics alone.

T	F		1	2	3	4	5	6	7	8	9	10

b. The use of an NSAID, ACE inhibitor and diuretic together increases this patient's risk of suffering drug-induced renal failure.

T	F		1	2	3	4	5	6	7	8	9	10

c. Adverse drug reactions may be precipitated by this patient's dehydration.

T	F		1	2	3	4	5	6	7	8	9	10

d. Paracetamol is a poor choice of analgesic in this patient.

T	F		1	2	3	4	5	6	7	8	9	10

e. Glomerular filtration rate and tubular secretion rate are unaffected by age.

T	F		1	2	3	4	5	6	7	8	9	10

7. Mixtard® 20/80 is biphasic biosynthetic human insulin suspension comprising 20% soluble insulin and 80% isophane insulin.

a. it is used in the management of diabetes mellitus.

T	F		1	2	3	4	5	6	7	8	9	10

b. side effects include hyperglycaemia.

T	F		1	2	3	4	5	6	7	8	9	10

c. the vial should be gently mixed before use.

T	F		1	2	3	4	5	6	7	8	9	10

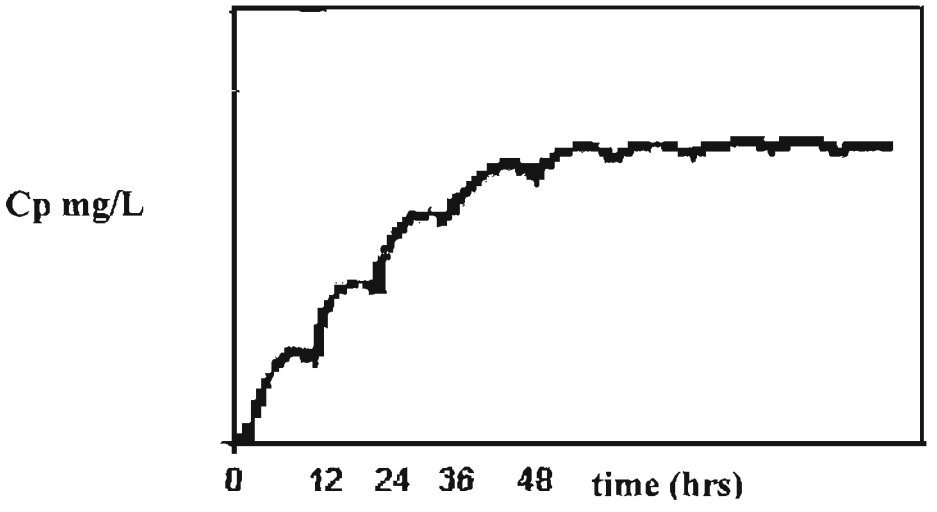
d. this preparation must not be administered intravenously.

T	F		1	2	3	4	5	6	7	8	9	10

e. this preparation is given *per os*.

T	F		1	2	3	4	5	6	7	8	9	10

8. An adult asthmatic is started on a maintenance dose of theophylline 200 mg twice daily (in the form of Theodur® which is a sustained release tablet). The diagram below shows how plasma concentration (Cp) varies with time (t) over approximately the next few days. The therapeutic range for theophylline is 10-20 mg/L.



a. the half-life of theophylline is about 8 hours.

T	F		1	2	3	4	5	6	7	8	9	10

b. Theodur® is a generic name.

T	F		1	2	3	4	5	6	7	8	9	10

c. if the patient was a smoker the steady state serum concentration (Cp_{ss}) resulting from this daily dose would be lower.

T	F		1	2	3	4	5	6	7	8	9	10

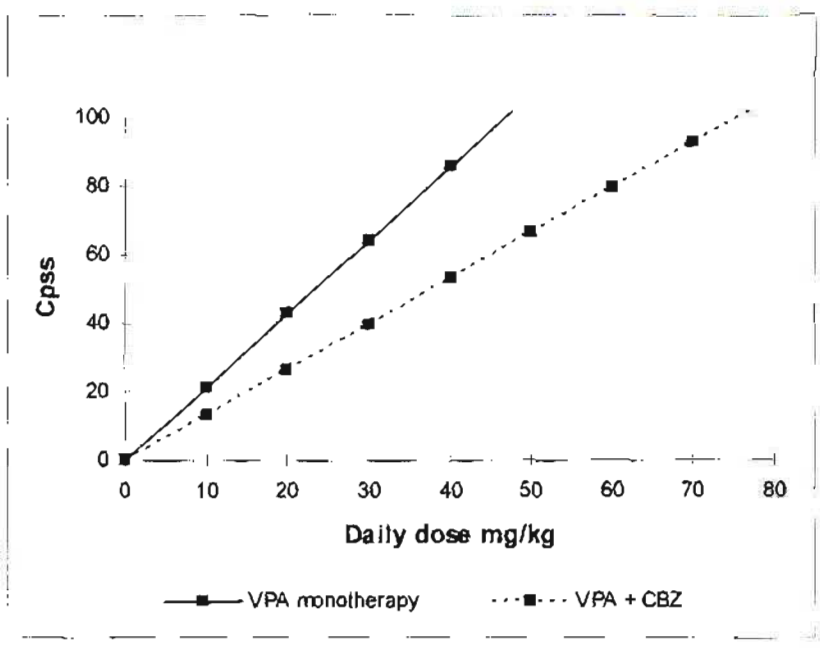
d. theophylline is a β_2 agonist.

T	F		1	2	3	4	5	6	7	8	9	10

e. theophylline is a placebo.

T	F		1	2	3	4	5	6	7	8	9	10

Question 9.



9. The graph shows the relationship between the daily dose and mean steady state serum concentration of sodium valproate (VPA) in a 20 kg child receiving valproate monotherapy and valproate in combination with carbamazepine (CBZ).

a. carbamazepine is an enzyme inducer.

T	F		1	2	3	4	5	6	7	8	9	10

b. valproate is an enzyme inducer.

T	F		1	2	3	4	5	6	7	8	9	10

c. children metabolise drugs faster than adults.

T	F		1	2	3	4	5	6	7	8	9	10

d. the elimination of valproate is a saturable process.

T	F		1	2	3	4	5	6	7	8	9	10

e. if the daily dose of valproate is increased by 50%, the resultant steady state plasma concentration will double.

T	F		1	2	3	4	5	6	7	8	9	10

10. Dr Pillay is managing 70 year old Mrs Ndlovu, who is being treated for breast cancer. In addition to her cytotoxic regimen, she is taking an antiemetic regimen which includes high dose metoclopramide. Dr Pillay phones the pharmacist for advice when Mrs Ndlovu develops a sudden body spasm, with her head and heels bent backward and her body bowed forward. Her tongue is protruding and she has facial grimacing.

a. Mrs Ndlovu shows signs of an acute dystonic reaction.

T	F		1	2	3	4	5	6	7	8	9	10

b. The pharmacist should explain that metoclopramide may act as an agonist at the dopamine receptors in the extrapyramidal system.

T	F		1	2	3	4	5	6	7	8	9	10

c. A lack of dopamine accompanied by an oversupply of acetylcholine in the extrapyramidal system may cause extrapyramidal symptoms.

T	F		1	2	3	4	5	6	7	8	9	10

b. The pharmacist should advise Dr Pillay to administer the anticholinergic biperiden which he will find on the injectable trolley.

T	F		1	2	3	4	5	6	7	8	9	10

c. Dr Pillay should be advised to switch Mrs Ndlovu's medication to a $5HT_3$ antagonist such as ondansetron.

T	F		1	2	3	4	5	6	7	8	9	10

11. 60 year old Mr Maharaj is diagnosed with type 2 diabetes. His serum creatinine is within the normal range. He does not drink alcohol nor smoke, he is overweight, but otherwise well. Fasting blood glucose is 10 mmol/l and glycated haemoglobin (HbA_{1C}) is 8.5%. Metformin is prescribed.

a. Maintaining the blood glucose as close as possible to normal decreases the incidence of complications in both type 1 and type 2 diabetes.

T	F		1	2	3	4	5	6	7	8	9	10

b. Diet, exercise and weight loss are extremely important in the management of type 2 diabetes as this lowers blood glucose concentrations and decreases coexisting risk factors for cardiac disease.

T	F		1	2	3	4	5	6	7	8	9	10

c. Metformin is a suitable first line choice in managing Mr Maharaj's diabetes.

T	F		1	2	3	4	5	6	7	8	9	10

d. Mr Maharaj should be warned that metformin commonly causes hypoglycaemia.

T	F		1	2	3	4	5	6	7	8	9	10

e. Beta cell failure continues in patients treated with metformin, so after a few years of use a second oral hypoglycaemic or insulin may be added to his therapy.

T	F		1	2	3	4	5	6	7	8	9	10

12. Mrs Karlsen is a small-framed 73 year old, a known hypercholesterolaemic patient. She has been taking simvastatin 20 mg for 4 years. She does not have a positive family history, her BP is 135 / 95 mmHg and she takes hydrochlorothiazide 25 mg daily. She is a non-smoker, is not diabetic and does not have ischaemic heart disease. She does not follow a strict diet, but walks with the Fit for Life® programme.

Cholesterol levels as follows:

Total = 4.5 mmol/L
LDL = 3 mmol/L
HDL C = 1.65 mmol/l

Please refer to Question 12 in the Appendix.

Drug treatment is initiated in patients with risk of myocardial infarction over 10 years of >= 20% in individuals without ischaemic heart disease when lifestyle modification measures alone have failed.

She mentions that her legs are aching and she is feeling weak and stiff and that she feels worse when she walks anywhere. She feels under the weather, tired and sore and thinks it is probably the after effects of a sinus infection for which she took antihistamines and clarithromycin.

a. On her present treatment, Mrs Karlsen has a more than 10% risk of myocardial infarction over 10 years.

T	F		1	2	3	4	5	6	7	8	9	10

b. Mrs Karlsen's painful symptoms could be myopathy related to statin use potentiated by interaction with clarithromycin.

T	F		1	2	3	4	5	6	7	8	9	10

c. Considering that Mrs Karlsen's hypercholesterolaemia is well controlled and that she has been taking a statin with no complaints for an extended length of time, no laboratory tests are needed at this visit.

T	F		1	2	3	4	5	6	7	8	9	10

d. Mrs Karlsen's statin should be discontinued for the moment.

T	F		1	2	3	4	5	6	7	8	9	10

e. Mrs Karlsen should be advised to follow an anticonorary diet as a means of further reducing her 10 year risk of MI.

T	F		1	2	3	4	5	6	7	8	9	10

13. a. What is the main danger associated with the use of penicillins?

hypersensitivity

b. What is the worst clinical presentation of this problem?

anaphylaxis

c. What is the primary drug in the management of b.

adrenaline

d. Explain how the drug mentioned in c. works.

Binds to α receptors in circulation – vasoconstriction

β_1 receptors in heart – increases rate and force of contraction

β_2 receptors in lung – causes bronchodilation

(6)

14. Explain the mechanism by which neostigmine reverses the action of competitive muscle relaxants.

Neostigmine is an acetylycholinesterase (AChE) inhibitor. Acetylcholine (ACh) binds to cholinergic receptors and cause a response e.g. at the neuromuscular junction (NMJ) it stimulates muscle contracting. ACh is rapidly broken down naturally by the enzyme AChE. AChE inhibitors delay the breakdown if Ach and prolong the activity of endogenous. Ach, therefore provide cholinergic action. Competitive muscle relaxants bind to nicotinic receptors at NMJ and prevent the binding of ACh, in this way preventing depolarization of muscle cell membrane and inhibiting muscle contraction (complete with ACh at receptor, therefore competitive blockers). Action of these muscle relaxants can be overcome by increasing ACh by giving AChE1.

(4)

15. A patient is admitted with an acute myocardial infarction and is started on a low daily dose of aspirin.

The dose is too low for analgesia. Explain why this medication is being used.

Aspirin is a cox enzyme inhibitor (needed for the manufacture of PGs and Tx). Thromboxane is involved in platelet aggregation first step in formation of a thrombus. Blocking thromboxane production blocks platelet aggregation and therefore prevents formation and regrouping of a thrombus. (4)

16. a. Gentamicin is an antibiotic belonging to the group called aminoglycoside

b. The most important group of organisms against which it is active is

gram –ve bacilli (rods)

c. Nephrotoxicity is an important possible adverse effect of gentamicin. Explain how this adverse effect can be minimized.

Give the drug at a dosage interval where trough is allowed to get very low. Low troughs associated with lower side effect incidence. Allows drug to move from renal compartment back into systemic circulation. Effectiveness of drugs associated with high peak rather than constant level above MIC. Therefore go for once daily higher dose dosing rather than lower doses more often.

(4)

17. Fill in the blanks:

HIV mutates rapidly and there is a high viral turnover. Inappropriate drug prescribing may cause rapid development of resistance. The use of a combination of three or more antiretrovirals to achieve durable suppression of replication is called HAART.

Drugs from the class protease inhibitors (e.g. indinavir, lopinavir and ritonavir) should be reserved for second line therapy, when the first treatment regimen fails. In contrast to treating established infection, the short term use of monotherapy with, for example nevirapine, is effective for PMCT of HIV. Combination therapy is more effective and may delay the emergence of resistance.

(4)

18. Mrs Evans arrives at the pharmacy, where you are working as a student, with a complaint about the medical aid who has changed her medication for her duodenal ulcer from ranitidine to the following:

Clarithromycin	500 mg bd	x $^{1}/_{52}$
Amoxycillin	1g bd	x $^{1}/_{52}$
Omeprazole	10 mg daily	x $^{4}/_{52}$

She recognizes the amoxicillin as the name of an antibiotic that had been given to her daughter to treat an ear infection and asks why these are needed to treat ulcers. She also complains that she is looking yellow and you notice this as well. Explain to her the rationale behind the prescription and give your advice.

2 ABS clarithromycin and amoxiciffin used to eradicate *h. pylori* which is a risk factor for ulcer. Omeprazole is a proton pump inhibitor which decreases stomach acid, therefore allowing ulcer to heal and alleviate symptoms. Clarithromycin may cause liver disturbance and jaundice so may need to see doctor and possibly change regimen (tetra and flagyl).

(3)

19. You are required to give the usual maximum allowed dose of cefotaxime (Claforan®) by intravenous infusion to a 12kg child with meningitis. Use the package insert provided to describe how you would prepare and administer the drug.

Please refer to Question 19 in the Appendix.

12kg boy Insert 200mg 1kg 1 day

2400mg/day ÷ 4 = 600mg

1g vial 4mL water

1000mg in 4mL water

1mg in 4mL water = 4 ÷ 1000

600mg in 4mL water = 4 ÷ 1000 x 600 = 2.4 mL and add to 50mL

saline over 20 minutes.

---

20. Use the package insert included to explain how you would manage the following patient.

Please refer to Question 20 in the Appendix

Mrs Bloggs, who is 82 years old, is diagnosed with angina and has been prescribed glyceryl trinitrate tablets for her acute attacks. How would you advise her to take the tablets, for what adverse effects is she specially at risk, and what can she do to prevent these problems?

Advice: Allow them to dissolve in mouth. Take second tablet if required and repeat as required. Take it as soon as pain is felt as effectiveness increases if given early. Seek medical attention if more that 6 doses in 15 minutes.

Adverse effects: hypotension and syncapse

Prevention: Sit down when taking tablet.

(4)

Appendix II Student Evaluation Questionnaire

DEPARTMENT OF PHARMACOLOGY, 2004
NELSON R MANDELA SCHOOL OF MEDICINE

Dear students
Today we are evaluating the vacation tutorial and ask you to please assist by answering the attached questions. We guarantee that NONE of this information will be conveyed to SUME or the Faculty and that it will in NO WAY influence your performance record either negatively or positively.

Julia Botha, Head of Department

I agree to answer the questions, on the understanding that the results will be used to help with the evaluation of the holiday tutorials and will in no way influence my assessment for degree purposes.
I consent to the possible written publication of the overall findings provided that my identity is kept confidential, and that I can in no way be identified via the text.

Signed_____ Name_____
Student number_____

Which pharmacology holiday tutorials did you attend?

All (everything)	All lectures	Some lectures	All cases	Some cases	None

If you answered NONE (above) do not answer further questions but hand back your form at this stage.

Why did you join the holiday tutorials?

Rate the following by choosing one of the nos.1-5 where 1 is the poorest and 5 is the best rating

1a. How well do you think you understood the steps in the prescribing process before the holiday tutorials?

1	2	3	4	5

1b. Consider your ability to follow the steps in the prescribing process. Do you think the holiday tutorials made no difference to this skill, improved this skill or made this skill worse?

	Choose 1					
It stayed the same						
It improved		1	2	3	4	5
Made skill worse		1	2	3	4	5

2a. How good do you think your verbal understanding of texts such as guidelines, package inserts, the SAMF and the Essential Drugs List was before the holiday tutorials?

1	2	3	4	5

2b. Do you think your verbal understanding of these texts changed as a result of the holiday tutorials?

	Choose 1					
It stayed the same						
It improved		1	2	3	4	5
It decreased		1	2	3	4	5

3a. How well do you think you understood graphical representations before the holiday tutorials?

1	2	3	4	5

3b. Do you think your understanding of graphical representations changed as a result of the holiday tutorials?

	Choose 1					
It stayed the same						
It improved		1	2	3	4	5
It decreased		1	2	3	4	5

4a. How well do you think you understood the arithmetical steps in dosage calculations before the holiday tutorials?

1	2	3	4	5

4b. Do you think your understanding of the arithmetical steps in dosage calculations changed as a result of the holiday tutorials?

	Choose 1					
It stayed the same						
It improved		1	2	3	4	5
It decreased		1	2	3	4	5

5a. How well do you think you understood the counselling skills involved in the prescribing process before the holiday tutorials?

1	2	3	4	5

5b. Do you think your understanding of the counselling skills involved in the prescribing process changed as a result of the holiday tutorials?

	Choose 1					
It stayed the same						
It improved		1	2	3	4	5
It decreased		1	2	3	4	5

6a. How well do you think you were able to critically analyze company communications (e.g. advertisements. drug representatives presentations) before the holiday tutorials?

1	2	3	4	5

6b. Do you think your ability to critically analyze company communications changed as a result of the holiday tutorials?

	Choose 1					
It stayed the same						
It improved		1	2	3	4	5
It decreased		1	2	3	4	5

Any comments about the holiday tutorials.

Any suggestions for future holiday tutorials.

APPENDIX III Paper published in the SA Journal of Higher Education

Building successful therapeutics into a problem-based medical curriculum in Africa

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Abstract

Irrational prescribing originates in undergraduate therapeutics education, where prescribing skills have been overlooked. Pdrug, a rational prescribing approach, has been developed in response to poor prescribing. In 2004, the first cohort of PBL final year students at Nelson R Mandela School of Medicine reported feeling unprepared to prescribe medicines and requested help. We aimed to assist students in improving their prescribing competence and confidence. Students were tested and asked to rate their confidence for some of their responses. A stratified sample of 10 of these students, were interviewed, where they prescribed treatment for 4 paper cases. A week-long intervention was designed, covering key areas of weakness and prescribing skills and employing several learning strategies. Students evaluated the course, rating how they felt key competences changed. Test results averaged 47 per cent. True/false questions were better answered (69 per cent) than short answer questions (21 per cent), the worst of these testing drug level interpretation (48 per cent) and dosage calculation (5 per cent) respectively. Students interviewed gave appropriate treatment for 4 of 40 cases and important patient information in only 1 case. Eight students gave an appropriate text for further information. The student evaluation showed an improvement for all prescribing abilities.

INTRODUCTION

Prescribing issues

Drug spending in South Africa accounted for 11.7 per cent and 36.6 per cent of the recurrent health budgets in the public and private sectors respectively in 1998. Aims of the National Drug Policy (NDP), published in 1996 as part of post-

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apartheid National Health Policy, included the promotion of rational drug use and the reorientation of the education of health care professionals toward the principles underlying the NDP.

Irrational prescribing is a common problem (Walley et al. 1993, 50±54). Bad prescribing habits lead to ineffective and unsafe treatment, harm to the patient and higher costs. They also make the prescriber vulnerable to influences causing irrational prescribing, including patient pressure, imitation of colleagues and marketing. New graduates will copy their practices, perpetuating the problem (De Vries et al. 1994, 1). De Vries et al refer to irrational prescribing as 'a habit which is difficult to cure'. (De Vries et al. 1995, 1454±1457).

Teaching and learning issues

The root of this problem appears to lie in undergraduate teaching. Therapeutics teaching is overlooked worldwide. Maxwell et al. (2003, 496±503) write of a 'pressing need for medical graduates to be fully prepared to take on the responsibilities of prescribing and to be able to respond to continual inevitable changes in therapeutics'. However, a survey of medical schools in the UK highlighted concern that insufficient time and resources were allocated to pharmacology and therapeutics teaching (Wally et al. 1994, 129±135). In one study, a group of University of Leeds Medical Students all raised the need for more therapeutics teaching in the undergraduate medical curriculum, and that their clinical training provided insufficient teaching of therapeutics (Ward et al. 2002, 129±135). These views are widely supported and clinical pharmacology training throughout the medical curriculum is advocated (General Medical Council 1993). The traditional focus, in pharmacotherapy teaching, has been on the transfer of knowledge about drugs, rather than on teaching the skill to treat patients. The result of this approach is that although pharmacological knowledge is acquired, practical prescribing skills remain weak (Hogerzeil et al. 2001, 1).

The act of prescribing is complex and requires a number of skills. Undergraduate medical students vary according to the extent to which they possess each of these abilities. One reason for this is because they have differing degrees of prior learning. Howard Gardner's multiple intelligence theory, made famous in the book Frames of mind in 1983, gives another explanation for differing capabilities. Gardner proposes that people have differing amounts of 9 intelligences: linguistic, logico-mathemati cal, bodily-kinaesthe tic, spatial, musical, interpersonal, intrapersonal, naturalist and existentialist. As a result of these intelligences people differ in the way they learn, and respond differently to various teaching techniques (Gardner 1999). Multiple intelligence theory has been embraced by educators as a tool for understanding and effectively meeting the learning needs of their students.

Self-directed learning is a teaching approach which involves the learner as an active participant. (Spencer and Jordan 1999, 1280±1283). Learners can choose

learning activities that suit the way they learn and accordingly it is not surprising that self-directed learning has been found to encourage a deep approach to learning, where learning is based on an understanding of concepts rather than on rote learning, and which improves retention of knowledge. Self-directed learning is the approach most likely to make doctors life-long learners and to prepare them for continually changing practice.

Problem-based learning (PBL) is one of several teaching strategies that have been developed to encourage self-directed learning. It is unlike traditional approaches, where new knowledge is provided before problems for solving. Instead students start with a specific problem (usually written) of 'phenomena that need explanation'. They identify issues which this problem raises to help develop understanding about underlying concepts and principles. New knowledge and understanding arise through working on the problem. PBL applies principles of learning acquisition: it activates prior knowledge, which determines what can be learnt subsequently; it allows for learning in context, which enhances transfer of knowledge to real situations; it allows for the elaboration of material, which enhances subsequent retrieval; and its inquisitive style allows for the development of information seeking techniques.

Several disadvantages of PBL have been identified and include expense, excessive demands on staff time, increased stress for students and staff, reduced acquisition of knowledge of basic sciences and implementation difficulties when class sizes are large or where there is lack of enthusiasm for the approach (Spencer and Jordan 1999, 1280±1283).

Despite these difficulties, a form of PBL has been developed as a response to the problem of poor prescribing and has been heralded as the way to prevent irrational prescribing. This is the development of a rational approach to prescribing known as the P-drug or P-treatment approach, outlined in a manual, the Guide to Good Prescribing (De Vries et al. 1994), designed for undergraduate medical students by the WHO Department of Essential Drugs and Medicines Policy. The manual presents students with a normative model for pharmacotherapeutic reasoning. First, students are taught to develop a standard treatment for common disorders, resulting in a set of first-choice drugs, called P(ersonal)-drugs. Students are taught to consult existing treatment guidelines, formularies, textbooks and other available sources of information. Then they are shown how to apply this set of P-drugs to specific patient problems, using a six-step problem-solving routine: (1) define the patient's problem; (2) specify the therapeutic objective; (3) verify the suitability of your p-drug and choose a treatment for this individual patient; (4) write a prescription; (5) inform and instruct the patient; and (6) monitor and/or stop the treatment. The rationale behind this approach is that medical students develop, during their studies or early in their career, a set of drugs which they will use regularly. This manual helps students to select P-drugs in a rational way, avoiding the early pressures of copying the prescribing behaviour of clinical teachers or peers without

consideration, as well as later pressures from commercial drug promotion. It also helps students use existing treatment guidelines appropriately, teaching them how to validate, and if necessary adapt, a generally recommended treatment to suit an individual patient (Hogerzeil et al. 2001, 1±3).

According to the Cape Town Declaration (WHO Regional Office for Africa 1995, 385±386), the education and training of a Doctor for Africa should be designed so that he/she is equipped to serve communities in Africa, such training being of an internationally recognized standard of excellence. The focus of education should be oriented towards producing generalists, with a shift in emphasis from curative to comprehensive health care. This document recommends PBL developed in response to an integrated core curriculum adapted to local conditions.

Around 150 medical schools worldwide (some 10 per cent of the total) have adopted problem-based curricula, and undergraduate teaching at the Nelson R Mandela School of Medicine has followed this trend. However, the majority of cases, used throughout this curriculum, focus on diagnosis, leaving students little time to select the most appropriate treatment from a variety of options.

In 2004, the first cohort of final year students (who had begun the PBL curriculum in 2001) reported feeling unprepared to prescribe medicines. They requested further contact sessions with our department to improve their prescribing competence and confidence. They were not able to say which specific topics or skills needed attention, but they reported enjoying paper prescribing problems where steps based on the P-treatment approach, described above, were used for reaching a treatment decision. Our aim was to design a short intervention to address the students' concerns.

METHODS

Pre-intervention test

In order to determine which skills and areas of knowledge needed attention, we prepared a test covering a broad range of material, including core topics and designed to test several prescribing skills. Table 1 gives a breakdown of these skills and the particular examples of material used in each case. Test questions consisted of 8 short questions as well as 12 problems, each followed by five true/false questions associated with the problem but unrelated to one another. Students were also asked to rate their level of confidence in the correctness of each of their true/false answers on a scale of 1±10. The test was administered before the start of a compulsory lecture to ensure that a high percentage of the class received and completed the test. Results of the test were analysed using Epi-Info Version 3. As data was normally distributed, (a Bartlett's test for inequality of population variances was used to check this), parametric tests (T tests) were used to compare the confidence ratings of students answering correctly and incorrectly.

Table 1: Topics and skills tested in the pre-intervention therapeutics test

Skill	Skill description	Topics and Material
1	Selecting appropriate treatment	± malaria ± post-natal depression and FDA-pregnancy categories ± Type 2 diabetes
2	Using guidelines to guide prescribing	± WHO Medical Eligibility Criteria for Starting Contraceptive Methods ± South African Dyslipidaemia Clinical Guideline
3	Medical literacy: understanding package inserts and the South African Medicines Formulary	± antiretrovirals: SAMF excerpt ± dosagecalculations:cefotaximepackageinsert ± insulin
4	Counselling	± missed contraceptive pill ± malaria prophylaxis
5	Critical assessment of company literature	± inhaled corticosteroids: advertisement
6	Detection, monitoring and treating drug-related adverse reactions	± adrenaline ± aminoglycoside antibiotics ± neostigmine ± insulin ± metoclopramide
7	Interpretation of drug levels/ monitoring and using these to guide prescribing	± valproate ± theophylline
8	Dosage calculation	± cefotaxime package insert
9	Avoiding /combating polypharmacy	± drug interaction: ibuprofen with cardiac failure medication

Interviews

Using the results of the pre-intervention test, 10 students were selected from across the spectrum of results, which ranged from 31±74 per cent. The sample was stratified to ensure representation from each of the following groups of results: 30± 39 per cent, 40±49 per cent, 50±59 per cent, 60 per cent and over. These students were invited to attend an interview where they were asked to consider the prescribing problems of four paper cases and to prescribe appropriate treatment for each. General comments about the course and the proposed intervention were also encouraged. The interviews were transcribed and analysed according to key themes using the qualitative research tool QSR NVivo version 2.

Intervention design

A week-long intense and focused session was designed for the class of 170 students. Areas of weakness highlighted during the test and student interviews were used to

guide the design of the intervention. We also attempted to include a focus on each of the key prescribing skills we had identified so that there was an opportunity for competence to develop in each area. A mix of learning strategies was employed. Large group sessions had a basic science focus, covering general overviews of pharmacokinetics, autonomic pharmacology and principles of antimicrobial treatment (40 per cent of 15 hours). A question and answer session was used to teach students how to use package inserts to find injectable antibiotic administration information and to calculate dosages (7 per cent of 15 hours). In the small group work sessions, students were presented with paper prescribing problems and followed the P-drug process to write an appropriate prescription which was then discussed with the rest of the class (53 per cent of 15 hours). The intervention was offered to all students who were interested and who were able to attend.

Student evaluation

Students who had participated in all or part of the intervention were subsequently asked to evaluate the programme during a standard lecture session. They were asked to rate their abilities for key areas for prescribing competence before the intervention and to rate on a scale of 1 to 5 how they felt their abilities changed as a result of the intervention. These abilities were a composite of the required skills listed in Table 1.

RESULTS

Pre-intervention test

The pre-intervention test was completed by 124 students of a total class of 170 (73 per cent). Thirty four students (27 per cent) scored 50 per cent and above, and the average mark achieved was 47 per cent. Students did not fare well in the short answer questions, attaining an average of 21 per cent. They did better in the true/false questions which were not negatively marked (69 per cent).

Table 2a and 2b show the results achieved for the short answer questions and the true/false questions respectively. The median confidence rating, which ranged from 3 to 8, is indicated in the last column. For the short questions, the best result (41 per cent) was obtained for a question testing counseling skills. The worst result (5 per cent) was obtained for a question testing dosage calculation. For the true/false questions, students achieved the best result for a question testing literacy (84 per cent with a median confidence rating of 7). The worst result was for a question about testing interpretation of drug levels (48 per cent, confidence rating 5). For two of the five parts of the best answered question, there was a statistical difference between the mean confidence rating for those students who answered the question correctly and those who did not, the confidence rating being greater for those who answered correctly (Table 2c). Likewise for the question answered worst there were also two parts where there was a statistically significant difference. In the one case the students who answered correctly were actually less confident than those

who did not. In addition, for the other part though students who answered correctly were confident than those who did not the difference between the two was much less than for the best answered question.

Table 2a: Summary of student test results: short answers

Skill number	Skill description	Topic	Result (Average percentage)
1	Selecting appropriate treatment	Antithrombotic action of aspirin	20
		Peptic ulcer treatment script analysis	28
3	Medical literacy	Antiretroviral combination therapy	18
4	Counselling	Glyceryl trinitrate treatment information	41*
6	Adverse drug reaction	Penicillin anaphylaxis	26
		Neostigmine antidote for muscle relaxant toxicity	13
		Aminoglycoside nephrotoxicity	15
8	Dosage calculation	Cefotaxime package insert	5**

* = top result
** = bottom result

Table 2b: Summary of student test results: true/false

Skill number	Skill description	Topic	Result (Average percentage)	Confidence rating (median)
1	Selecting appropriate treatment	Type 2 diabetes treatment	74	8
		Post-natal depression/ pregnancy categories	62	3
2	Using guidelines to guide prescribing	Contraceptive eligibility criteria	73	8
		Hypercholesterol aemia treatment	67	5
3	Medical literacy	Insulin	84*	7
4	Counselling	Malaria prophylaxis	73	7
		Missed pill	74	8
5	Critical assessment of company literature	Inhaled steroid advert	64	7
6	Adverse drug reactions	Dystonic reaction with metoclopramide	62	4
7	Interpretation of drug levels	Theophylline graph	61	6.5
		Valproate graph	48**	5
9	Avoiding/combati ng polypharmacy	Drug-interaction ibuprofen with cardiac failure medication	81*	6

* = top result
** = bottom result

Table 2c: Comparison of mean confidence rating for students answering correctly and incorrectly for selected questions

Topic	Reason for analysis	Overall median confidence rating	Mean confidence rating		T Statistic	P-value
			Answer Correct	Answer Incorrect		
Insulin	Best result	7				
Part 1	(84 per cent)		6.7(111)	3.5(6)	2.2665	0.0253
Part 2			7.9 (101)	4.6(16)	4.0323	0.0001
Part 3			5.2 (104)	5.5 (13)	0.3641	0.7165
Part 4			6.2 (75)	5.4 (43)	1.1427	0.2555
Part 5			7.1 (100)	5.5 (16)	1.7171	0.0887
Valproate	Worst result	5				
Part 1	(48 per cent)		6.7 (84)	5.1 (31)	2.3062	0.0229
Part 2			5.1 (43)	4.8 (71)	0.4391	0.6615
Part 3			5.1 (67)	6.0 (48)	1.3588	0.1769
Part 4			2.7 (42)	4 (65)	2.3061	0.0231
Part 5			5.1 (47)	4.5 (66)	0.9965	0.3212

Interviews

Ten students were interviewed. When analyzing the results the investigator was blinded to the student's test result. Lack of confidence was a common theme voiced by the interviewees Table 3 (see next page) gives a breakdown of the interviewees' treatment decisions.

Intervention

One hundred and six students (62 per cent) attended all or part of the intervention (85 per cent of those tested). Many of the students who did not attend were unable to do so because it was scheduled during the vacation when they were traveling to homes far from Durban.

Student evaluation

On the day of the evaluation 79 students attended (46 per cent of whole class). Evaluations were obtained from 60 students (57 per cent of the students had who attended the holiday sessions). Table 4 (on page 73) shows the median initial student rating of key prescribing abilities, as well as the change in these ratings after the holiday sessions.

Students contributed detailed comments in the open-ended section of the questionnaire. These were all very positive. Strengths of the course which were highlighted included student-departme nt relations, group work and time on task: some students liked having the intensive focused block of time. Several students reported that they felt a weakness of the sessions were that they were not assessed.

Table 3: Summary of student interviews

Result (per cent)	Appropriate treatment?	Important information	Information strategy	Treatment decision based on:			
				Efficacy	Safety	Suitability	Cost
64	Case 1 and 2 B Case 3 and 4 C	B	South African Medicines Formulary (SAMF)	C	Case 1 and 3 C	Case 4 C	B
60	All cases B	B	B	C	B	Case 2, 4 C	B
56	All cases B	B	SAMF Essential Drugs List (EDL)	C	Case 1 and 3 C	Case 4 C	B
54	Case 1 C Case 2, 3, 4 B	C Case 1 safety	SAMF	C	Case 2 C	Case 4 C	B
49	All cases B	B	SAMF	C	B	B	B
46	All cases B	B	SAMF	C	Case 3 C	Case 3, 4 C	B
43	All cases B	B	SAMF	C	All cases C	Case 1, 4 C	Case 1 C
41	Case 1 C Case 2, 3, 4 B	B	SAMF	C	Case 3 C	Case 2, 3, 4 C	Case 4 C
39	All cases B	B	SAMF Internet	C	C Case 3	Case 2, 4 C	B
33	All cases B	B	B	C	Case 3, 4 C	Case 2 C	B

Table 4: Median student rated increase in key prescribing abilities after intervention

Prescribing ability	Skill number	Skill description	Rating (original and final)				
Ability to follow the steps in the prescribing process	1 2 6 9	Selecting the appropriate treatment Using guidelines to guide prescribing Adverse drug reactions Polypharmacy	1	2	3	4	5
Verbal understanding of texts	2 3	Using guidelines to guide prescribing Medical literacy	1	2	3	4	5
Understanding of graphical representations	7	Interpretation of drug levels	1	2	3	4	5
Understanding of the arithmatic steps in dosage calculations	8	Dosage calculations	1	2	3	4	5
Understanding of the counselling skills involved in the prescribing process	4	Counselling	1	2	3	4	5
Ability to critically analyze company communications	5	Critical assessment of company literature	1	2	3	4	5

Suggestions for future improvements were also given. Most frequently requested was that this session be given as part of the curriculum early at the start of the students' training. Further requests included follow-up with prescribing exercises within each theme throughout the course and assessment of sessions.

DISCUSSION

Pre-intervention test

The results of the pre-intervention test were poor, with less than a third of students obtaining 50 per cent. This is in keeping with the worldwide trend of overlooking therapeutics training (General Medical Council 1993). We recognized that the focus of most PBL cases at our Medical School is on diagnosis. It appears that, in our setting, the PBL skills learnt while analyzing these diagnostic problems is not automatically transferred to solving of treatment problems. This finding is in line with those of Norman (1988, 279±286), who found no evidence that generic problem solving skills were enhanced through PBL.

Throughout their course, students are tested using a limited number of assessment methods which include the true/false questions linked to a case and which do not include short questions. The results for the short answers may be particularly poor (with an average mark of under 50 per cent) because students have no practice in this skill. Also, the true/false questions were not negatively marked and this may have inflated the results for these questions above a realistic level. Negative marking was not used because responses were linked to a confidence rating and students were asked to complete all the questions, giving a confidence rating of 1 for answers they did not know.

Of the short answer questions , the worst answered was a dosage calculation question (average 5 per cent.) The question required that students retrieve dosing information from a dense package insert, and explain the steps to appropriate dosing. There may be a number of reasons contributing to the particularly poor answering of this question. First, this kind of question was new to students and they may not have fully understood what was required of them. Second, while package inserts have been available as an information source throughout their studies, students have not been guided through them explicitly. Incorrect responses included some where students retrieved inappropriate information and used this in an attempt to calculate a dose, possibly indicating a medical literacy problem. Third, students had difficulty calculating appropriate drug volumes, suggesting that numeracy skills were weak.

Even for the best answered short question (counseling messages in angina treatment), students only attained an average of 41 per cent. The question also included a package insert, but this was less detailed and students may have learned appropriate patient information elsewhere. The best answered true/false questions related to important safety information given in an insulin package insert. This topic had been extensively covered in an introductory lecture. The difference in

results for these questions, which all required some ability to make sense of information from a package insert, suggested that students needed guidance negotiating this information source.

The worst answered true/false questions were those which required an understanding of how to read graphs. The most poorly answered of these, (about the anticonvulsant valproate) related to material not explicitly covered in a lecture, while the other (about theophylline), which had been covered, was better answered with an average mark of over 50 per cent.

Considering students' confidence in relation to their responses, an analysis of the best answered true/false question, (the insulin question), shows that for two of the five parts of this question, students who answered correctly had a significantly higher confidence rating than those who did not. However, results were disturbing for one part of the worst answered question. Here students who answered incorrectly had a higher confidence rating (statistically significant) than students who gave the right answer. Students who are convinced of an incorrect assumption are not likely to develop prescribing competence in the area concerned so this finding indicated that students needed help understanding graphical representations.

Interviews

With an appropriate prescription given for only 4 of a possible 40 cases, findings about prescriber competence from the 10 students interviewed were in keeping with those of the test. The disappointing lack of patient counselling given emphasizes the need for these skills to be taught explicitly and practiced if patients are to receive appropriate treatment support. More encouraging is the finding that eight out of ten students suggested an appropriate source of prescribing information, the South African Medicines Formulary (Division of Pharmacology, UCT 2003). Prescribers willing to consult such a reference to assist in drug selection are more likely to make an appropriate choice. If students had been allowed to consult a reference during the interview, there may have been more appropriate prescriptions. This finding might be a result of PBL, where information seeking skills are emphasized.

All students considered drug efficacy in making their prescribing decisions, but they differed as to where their choice of drugs originated. Some thought of drugs they had used themselves, some remembered drugs mentioned in a lecture or by a consultant during clinic visit. We expect the best prescribing decisions to be those where the benefit of efficacy and patient suitability is weighed against drug safety considerations and financial cost. There was evidence that some students made decisions based on these considerations.

> There seemed to be no correlation between the reasoning ability of an interviewee and either his/her test results or the median overall confidence rating given for true/false questions. Students who prescribed appropriately for one or more paper cases

ranked first (with a confidence rating of 4.5), fourth (with no confidence ratings given) and eighth (with a confidence rating of 7.5) according to test results. The number of students interviewed was small, so this finding should not be considered representative of the whole class.

Evaluation

Students reported an improvement in confidence for each of the prescribing abilities listed. A shortcoming of the study, however, is that the initial rating was undertaken retrospectively and is subject to recall bias. Overall, the evaluation was positive and there was a sense of improved abilities. Strengths of the course articulated in the student evaluation questionnaire compare with several of the qualities highlighted in 7 Principles for Good Practice in Undergraduate Education (Johnson Foundation 1987). According to this document, the encouragement of student-faculty contact, of co-operation among students and of active learning; prompt feedback; spending time working on a task; communicating high expectations and the promotion of diverse talents and ways of learning all foster good learning.

Importance of confidence

Confidence is an attitude based on a belief that a person has the ability to do something effectively, so prescribing confidence is the students' belief that they will be able to prescribe an appropriate treatment for a patient in their care. Albert Bandura's theory of social learning provides a useful framework showing the relationship between what he calls self-efficacy expectation and motivation to perform an action (Bandura 1977, 191±215, 2000). According to this theory, we are motivated to perform an action if we believe the action will have a favourable result (outcome expectation) and we are confident that we can perform successfully (self-efficacy expectation). The psychological construct of self-efficacy has been equated with confidence (Bleicher and Lindgren 2002). The common term a caregiver involved in prescribing would use to express feelings of self-efficacy relating to prescribing would be prescribing confidence. If Bandura's theory of social learning is related to appropriate prescribing, the prescriber's lack of confidence in his ability to prescribe appropriately will influence his performance and he will less likely motivated to ensure an appropriate script. An improvement in student prescribing confidence should, therefore, herald better prescribing.

Curriculum change

The importance of student feedback in curriculum design is well recognized (Huppatz 1996, 9±13.). The findings of this study have informed the development

of a therapeutics module within a new foundation theme where basic sciences are stressed and which includes an assessment at the end of the course, Students participate in this theme at the start of their medical studies which should help to prevent the development of lack of prescribing confidence. We hope that these changes will begin to address student needs and recommendations.

Recommendations

In Africa, the lack of technical support for the appropriate use of essential medicines and the benefits of a teaching approach which increases rational prescribing has been recognized (Barnes 1997). We hope to strengthen student prescribing by introducing a followup to the foundation theme sessions, providing prescribing exercises and opportunities for students to practice caregiver-patien t interactions. These would be linked to themes throughout the course.

We will endeavour to include further learning strategies to focus on competences where the improvement in confidence was less marked than for other skills: counseling, verbal understanding of texts and critical analysis of company communications.

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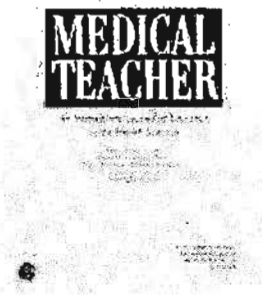
APPENDIX IV Paper submitted to Medical Teacher



Undergraduate medical students' reasoning with regard to the prescribing process

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Undergraduate medical students' reasoning with regard to the prescribing process

Running head: Reasoning and the prescribing process

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KEY WORDS

Irrational prescribing, prescribing competence, prescribing skills, student confidence, phenomenographic analysis, reasoning, Africa

ABSTRACT

When final year medical students reporting poor prescribing confidence were tested, key prescribing weaknesses were found. This study aimed to determine students' different experiences and the range of their levels of cognition associated with prescribing. Student assessment components was analysed. For the quantitative instrument (a test evaluating prescribing ability,). Blooms Taxonomy cognitive categories were assigned to each question. Most questions (78%) focused on the lower half of the Bloom hierarchy. For the true/false questions, students scored highest within the lowest two cognitive categories. Results were lower for mid-ranging abilities and were lowest for the highest ranking category, 'evaluation'. For short-answer questions, the lowest and highest ranked cognitive categories produced the best (36.9%) and worst (16.6%) average results respectively. The qualitative data, gathered from student interviews, revealed prescribing reasoning predominating at different Bloom levels. Also included were treatment decisions for paper cases. Analysis according to a phenomenographic method exposed different understanding of the prescribing process. This ranged from the mechanistic use of a medicine to including the patient in a more holistic manner. Our subsequent intervention increased student prescribing confidence. We believe thatstudent conceptions about prescribing were developed through strengthening lower cognitive abilities, while also spotlighting evaluation and integration.

INTRODUCTION

When final year students at the Nelson R Mandela School of Medicine, Durban, South Africa, who had reported feeling unprepared to prescribe medicines were tested, both

qualitative and quantitative components of their assessment showed shortcomings in key prescribing skills. Details of this assessment as well as the design and evaluation of the intervention, have been published previously. (Harries et al., 2006). This group was the first cohort of final year students following a new curriculum focused around self –directed learning. With the introduction of this curriculum in 2001, our medical school had joined the ranks of some 150 medical schools worldwide (some 10% of the total) which have followed this trend.

The act of prescribing is complex and requires a number of skills. Bloom (1956) developed lists of the capabilities required by graduates for the development of competence in their chosen field. He arranged these capabilities in three separate domains for each of three areas of mental processing: cognition, affect and psychomotor skills (Bloom's Taxonomy for the domain in question). Within each domain, capabilities were ranked in a hierarchy of increasing difficulty, with each new capability demanding competence in the preceding skills. Categories within each domain are listed in Table 1. The act of making a prescribing decision involves the two most complex capabilities within Bloom's Taxonomy (cognitive domain). Prescribing requires an ability to select a medicine, weighing treatment benefits and costs based on the best available evidence. This ability corresponds with Bloom's cognitive level of evaluation. The decision is communicated via the patient – caregiver prescribing interaction. This is a creative act that should provide the patient with the tools to manage the health problem in question. In addition abilities falling within the other two domains, namely affect and psychomotor skills, are prerequisites to the development of cognitive skills leading to prescribing competence.

Undergraduate medical students possess varying amounts of each of these abilities. Differing life experiences provide one explanation for this. Another reason for differing capabilities is given by the notion of learning styles. Theorists vary according to whether these learning styles are relatively fixed characteristics of an individual or more flexible learning strategies developed in response to a particular context. These different views have been represented as a spectrum of learning styles (Coffield et al., 2004). Howard Gardner's multiple intelligence theory, made famous in the book *Frames of mind* in 1983, is located toward the fixed end of the spectrum. Gardner proposes that people have differing amounts of various intelligences, including the traditionally accepted linguistic and logico-mathematical intelligences as well as others such as musical, interpersonal and existentialist intelligences. Such differences would explain why people vary in the way they learn, and why they respond differently to various teaching techniques (Gardner, 1999). Educators have found this theory a helpful tool enabling them to understand and effectively meet the learning needs of their students.

On the other hand, the work of Entwistle is located at the flexible end of the learning strategies spectrum. He supports the view that there are two main student approaches to learning: deep and surface learning, where students aim to understand meaning or use rote learning to cope with the demands of the assessment, respectively. He also recognises a strategic approach, where a combination of deep and surface learning is used to achieve high grades. The choice of learning approach was profoundly affected by factors such as the way learning was assessed, the type of learning strategy used and the students' level of anxiety about material to be covered (Entwistle and Ramsden, 1983).

Weak practical prescribing skills are a worldwide problem. (Walley et al., 1994; Ward et al., 2002). They are considered to be the consequence of the focus, in pharmacotherapy teaching, on the transfer of knowledge about drugs, rather than on teaching the skill to treat patients (Hogerzeil, 2001). The implications of the neglect of therapeutics teaching in the undergraduate curriculum are far-reaching. During their undergraduate years or their early years of practice, doctors are believed to build up a mental set of medicines which they are most likely to prescribe. Students who are not taught to approach prescribing in a rational way in their undergraduate years are less likely to have a rationally-based group of drugs from which to choose. They are more likely to succumb to influences such as patient pressure, imitation of colleagues and marketing which will cause irrational prescribing after they graduate (De Vries et al., 1994). Once doctors are prescribing irrationally the habit is entrenched and, as described by De Vries et al. (1995), "difficult to cure". Denig et al. (2001) studied the cognitive processes of doctors making a prescribing decision and report that decision-making processes were not extensive, with little contemplation involved in a decision and habitual behaviour being observed. Irrational prescribing, a common problem, exacerbates ineffective, unsafe, unsuitable and unnecessarily expensive patient care. (Walley et al., 1993).

One response to irrational prescribing, by the WHO Department of Essential Drugs and Medicines Policy, which has been shown to improve this problem, has been the development of a rational prescribing approach known as the P-drug or P-treatment approach which is described in a manual for undergraduate medical students, the *Guide to Good Prescribing* (De Vries et al., 1995; De Vries et al., 1994). Through

following a step-by step prescribing problem–solving routine, the cognitive processes involved in making and communicating a prescribing decision are laid bare. In order to complete the task, students must practice skills which include the higher cognitive abilities of evaluation and integration. In addition to associating a treatment with a particular disease, the explicit nature of the approach helps students reflect on the *process* of selecting an appropriate treatment. Such teaching strategies develop metacognitive skills, and are associated with an increase in the depth of learning and with the development of learner autonomy (Sadler-Smith, 2001 *loc cit.* Coffield, F et al., 2004, p. 128).

Our ideal in the design of an intervention to improve prescribing skills was to allow students to experience such an approach, the benefits of which have been recognized for Africa (Barnes, 1997). We also planned to include the use of South African Standard Treatment Guidelines to keep the focus of problems relevant to the needs of the region as has been identified as key to the development of a Doctor for Africa (WHO Regional Office for Africa, 1995). However, we took into account Angelo's Fourth Principle for improving higher learning (Angelo, 1993), that "to be remembered, new information must be meaningfully connected to prior knowledge", that cognitive skills build in a hierarchical fashion and that a student with poor comprehension of the role of a drug in a disease or the inability to find the knowledge that was needed, would not be able to reach the steps of evaluating data to make a prescribing decision and of integrating information to reach treatment solutions with a patient. Entwistle also cautioned that this pitching of a teaching interaction at an appropriate level, particularly for the science subjects, was needed to encourage a deep approach to learning (Entwistle & Ramsden, 1983).

Our challenge was how best to improve therapeutics learning, given the complexity of the prescribing process, the varying capabilities of students, and the benefits that have been shown to derive from learning to approach prescribing rationally. In order to answer these questions and to pitch our interventions appropriately, we sought to 'know our learners', not only in terms of skills but in terms of their thinking related to the prescribing process. Consequently, our objectives were to examine the levels of reasoning that predominated when students were engaged in tasks requiring key prescribing skills and to determine how students perceived the act of prescribing.

METHODS

Entwistle and Ramsden (1983) argue that a mix of quantitative and qualitative research is necessary to understand student learning. Our student assessment included an interpretive research perspective to complement the otherwise quantitative research methodology. In the case of the quantitative instrument, which was a test assessing student prescribing ability, a category from Blooms Taxonomy (Cognitive domain), which best described the cognitive ability needed to answer appropriately, was selected and assigned to each test question. Questions were grouped according to the cognitive category assigned to them, and the average score achieved by students for each category was calculated.

Next, the qualitative data were reviewed. This had been gathered from the interviews of a stratified sample of ten of the original students tested, and included general comments about the course and the proposed intervention as well as students' treatment decisions for four paper cases. The 'think aloud' method had been used to

expose the students' decision processes and to give insight into their conceptions of prescribing. This involves asking students to verbalise thoughts that come to mind while making a prescribing decision (Denig et al., 2002).

Using NVivo version 2.0 (a software product for qualitative data analysis), passages of transcripts of student interviews were scrutinized for students' opinions about why they were not confident of their prescribing abilities. Similar views were grouped together and tagged or 'coded' at different 'nodes'. Node information was profiled according to the number of characters and paragraphs coded within each node, giving an indication of the amount of discussion generated for each kind of opinion. Also included were the number of passages and documents (student transcripts) coded, the former indicatingthe frequency with which a particular opinion was raised, and the latter showing whether the opinion was broadly shared or held by only a few individuals.

Next, the portion of the student interview transcripts relating to two of the prescribing problems (concerning asthma and otitis media) was scrutinized. The two problems were selected randomly from the four paper cases used in the student interviews. This allowed the variation in the students' reasoning during the prescribing process to be examined and possible differences in their conceptions of prescribing to be uncovered. A phenomenographic approach was used. (Marton et al., 1994, *loc cit.*, Land of Phenomenography website). This entails the scrutiny and detailed description, using an iterative process, of the limited number of qualitatively different ways in which a phenomenon is experienced. Each description should reveal the different capabilities for understanding the phenomenon in question.

Prescribing decisions were examined (to determine the reasoning and conceptions related to treatment that these responses revealed) and ranked according to the variation between them. Each understanding was carefully described in order to bring out its special characteristics relative to the others, together forming a set of *categories of description*. A logical relationship between the different ways of understanding the text was sought in an attempt to establish a hierarchy between the categories of description, and to produce the set of categories known as the *outcome space*.

In response to the students' request for assistance, an intervention was designed. This comprised a mix of large group sessions (with overviews of inter-related concepts forming a key focus) and small group work where students practiced the P-treatment approach to prescribe for paper cases. Students used standard treatment guidelines, giving themthe chance to ref lect upon the utility of these to support their prescribing decision. This exposure also allowed some critical evaluation of the recommendations, a step which has been identified as key to the use by practitioners of guidelines in their practice. (Brown et al., 2003).

Subsequently, in order to evaluate altered confidence, participants were asked to rate their key prescribing skills prior to, and after, the intervention on a scale of one to five. This revealed how they felt the intervention had changed their abilities. The intervention and its evaluation have been described previously (Harries et al 2006).

RESULTS

Table 2 shows the proportion of test questions, expressed as a percentage, that can be ascribed to each category. Tables 3 and 4 give the breakdown of questions assigned to each Bloom cognitive category for the true/false questions and short answer questions respectively. The average results were highest for true/false questions within the first two cognitive categories ('knowledge' and 'comprehension'), and fell for the higher ranked categories of 'application' and 'analysis'. Results decreased even further for the highest ranking category, 'evaluation'. For the short answers, the lowest ranking cognitive skill, 'knowledge' achieved the best score (36.9%). Next best was 'application', which in fact scored higher than the lower ranking cognitive skill, 'comprehension'. The poorest score was achieved by 'synthesis', the highest cognitive skill assessed using the short answer question methods.

Table 5 details problems that students encountered. The most frequently encountered problem (for five out of ten interviewees) was their concern that they lacked a prescribing strategy. Between these five students there were 15 paragraphs (1819 characters) regarding this particular issue. The problem of lack of knowledge about drug doses generated the most discussion (with 2017 characters coded at this node). Four students mentioned this.

Tables 6 and 7 give the outcome space (in the phenomenographic sense) developed from what was exposed of students' conception of prescribing from the transcript subsets relating to uncontrolled asthma and otitis media respectively. This reveals student experience viewed from two different angles. The variation appears to fall within five and four categories respectively.

After the intervention, evaluation of student confidence revealed increased self-assessed ratings for all prescribing abilities. This provided evidence of changed thinking leading to improvement in confidence (Harries et al. 2006).

DISCUSSION

Recommendations of the July 2002 publication of *Tomorrow's doctors* by the General Medical Council in the UK are that medical schools develop valid and reliable assessments to ensure their students meet key treatment objectives. These outcomes have been designed to show students' ability to face the practical issues of weighing the risks and benefits of drug therapy, of prescribing a treatment and of monitoring the impact of therapy. Included among these key objectives are the ability to evaluate effectiveness against evidence, recognition of the need to take into account the patient's own views and beliefs, and the expectation that students should be able to provide enough information about conditions and possible treatments to allow patients to make informed decisions about their care (Webb and Maxwell, 2002).

Although our questions had been designed to try and assess key prescribing skills and are typical of those we submit to form part of the student's general assessment, only 16% evaluated higher skills. The middle range abilities of application and analysis were tested in 37% of questions, while 47% of the paper tested the lowest ranked cognitive skills of knowledge and comprehension. This is recognised as a shortcoming as students must use the full complement of cognitive skills, including the higher order abilities of evaluation and synthesis, in order to be able to prescribe a treatment and help patients look after themselves optimally. This focus on lower cognitive ability is a challenge for educators across disciplines (Stiggins et al., 1989;

Whittington, 1995), one in fact which lead Bloom to develop his Taxonomy as a tool for evaluating and improving teaching and assessment in relation to the professional skills educators aimed to develop (Chapman. *loc cit.,* www.businessballs.com website).

An assessment method is needed which, at least, tests the spread of cognitive abilities more evenly and, at best, reverses the focus, so as to emphasise evaluation and synthesis and minimise the assessment of the lower order skills. The ability to evaluate and synthesize requires competence in the lower order cognitive skills, and therefore these latter skills can be assumed where students show ability in the higher-order cognitive skills. This matching of a test with the cognitive skills required for competence in the function being tested is particularly significant considering Entwistle's finding that the way learning is assessed deeply affects whether a student will choose a deep or surface learning approach (Entwistle and Ramsden, 1983).

To a large extent, student results, analysed according to the Bloom hierarchy of cognitive skills, formed a pattern showing greater ability within the lower cognitive domains, with achievement falling with an increase in the level of cognitive skill assessed. However, in one instance, in the analysis of the short answer questions this trend was not observed: For the category 'application', the achievement shown exceeded that of a lower cognitive category, 'comprehension'. A possible explanation for this is that students in fact have a better understanding than their linguistic skills allow them to display when answering questions requiring demonstration of comprehension in a short answer format. The questions testing application, on the other hand, usually require the ability to understand details of a case applied to a

particular context. This is usually demonstrated by answering very short questions related to the case which do not require as sophisticated writing skills as those testing comprehension which require the writing of detailed explanations.

The test results suggest that reasoning related to the prescribing process occurred predominantly at the lower Bloom cognitive levels. In these students, this low-level reasoning co-occurred with poor prescribing skills (with overall test results averaging 47%) and confidence levels low enough to drive students to report their concerns and seek special assistance (Harries et al., 2006).

The students' lack of ability in the higher cognitive areas has to be viewed in the light of the fact that the spread of test questions was uneven. Their poor ability in these areas may have, in part, been due to the fact that there were fewer questions (16%) in these categories.

Regarding the problems highlighted by students (Table 5), the comments reveal something of their conception of learning itself, as described in Bloom's Taxonomy and by Entwistle *et al.* For example, those relating to insufficient coverage and to a lack of knowledge about drug dosages both revealed an understanding of learning as a body of knowledge that has to be transferred from the teacher to the learner. This is a conception associated with surface learning. These views show an understanding of cognitive ability that is limited to recall. On the other hand, the comment describing the category 'lack of basic science' reveals a student struggling with the cognitive demands of comprehension, while the comments relating to the 'lack of prescribing

strategy' show students with some understanding of the evaluative skills required in order to prescribe competently.

The phenomenographic part of the analysis gives insight into student conceptions of the prescribing process. The outcome space described in Table 6 shows the prescribing decision evolving to an increasingly complex reasoning process. In addition, as the conception develops, an understanding of the role of the patient appears to change. In the first category, the student's consideration of the patient was limited to the level of the organ concerned. Over the next categories a more holistic approach developed such that by the third category students consider patient characteristics in relation to treatment. In the fourth category the patient was seen as an individual attached to a context (in this case a work situation which might exacerbate asthma symptoms). In the final category the student recognised that optimum prescribing is also dependant on the participation and motivation of the patient in the prescribing decision.

The conceptions of prescribing exposed after analysis of the otitis media case material (Table 7), while showing increasing levels of conception of the prescribing process with increasing category number, do differ from those revealed through the asthma prescribing case. This is because selection of an effective treatment requires an understanding that an underlying causative organism must be targeted. Category IV for the otitis media description can be compared with category II for the asthma case. For the otitis media example, students did not display the higher levels of conception seen with the asthma question, perhaps because the focus of their cognitive efforts was around selection of an effective drug which is a more complex process in the case

of selecting an antibiotic. One of the concepts underpinning phenomenography is the view that an object is inseparable from its contextual field. With this in mind, it is not surprising that two different prescribing situations yielded two differing perspectives of student conceptions.

For both the clinical cases above, the majority of students fell within the middle levels, in contrast to the quantitative findings where performance was best at the lower levels of cognition. This may be an indication of the fact that an improved ability to reason about the problem of prescribing (as measured by qualitative findings) may precede, and be a step towards, the better outcome based quantitative assessment. This is line with the views of the Gothenberg phenomenographers (Marton et al.,1994 *loc. cit.* Land of phenomenography website.)

We conclude that reasoning among our students in relation to prescribing predominated at the lower cognitive levels and that this was being reinforced by current assessment methods. The result of this was that when students came into contact with real-world prescribing requirements, as occurred during their clinical years, and measured their abilities against these, they found themselves lacking. The frustration this produced can be seen in the conflicting reasons given for their lack of competence, ascribing this on one hand to insufficient course content, (particularly related to dosage) and on the other to not having been taught a strategy for selecting drugs. This conflict often existed even within the same students.

It is our view that the latter was the cause of their frustration, and that there is insufficient focus on teaching students how to think about choosing drugs. We feel the

reasons why our intervention made students feel more confident about their prescribing abilities, are in line with Apter's Theory of Motivational Styles (Coffield, F et al., 2004, p.52). This theory states that two of the main reasons for switching between motivational styles are frustration and satiation. When such 'reversals' are prevented by attending timeously to causes of frustration, for example, by diagnosing gaps in understanding and by developing strategies to remedy these, motivation is maintained and learning can continue.

We believe a balance was struck between providing guidance toward drug selection without losing the importance of the core knowledge which underpins this ability. This balance shifted student thinking about prescribing in such a way that students felt more confident of their prescribing abilities. Thus our intervention served an integrative purpose, helping students fit discrete bits of knowledge together, an ability associated with high quality learning outcomes (Prosser and Trigwell, 1999).

A fundamental concept of Gestalt therapy theory is that human beings cannot refrain from organizing perceptions into meaningful sets or forms as they have new experiences, the result of which is learning and change (Kirchner, 2000). We have uncovered distinct changes in conceptions related to prescribing, the patient being considered in more close and complex ways with each shift in the form of thinking. This understanding will inform our teaching as we strive to guide students toward more mature forms of conceiving the act of prescribing

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Table 1
Categories of the Bloom's Taxonomy Domains

Cognitive ***Knowledge***	**Affective** ***Attitude***	**Psychomotor** ***Skills***
Recall data	Receive (awareness)	Imitate
Understand	Respond (react)	Manipulate (follow instructions)
Apply (use)	Value (understand and act)	Develop precision
Analyse structure/elements	Organise personal value system	Articulate (combine, integrate related skills)
Synthesize (create/build)	Internalise value system (adopt behaviour)	Naturalisation (automate, become expert)
Evaluate (assess, judge in relational terms)		

Table 2
Percentage of questions in each Category in the Bloom Cognitive Domain

Bloom Category	true/false questions	short answer questions	overall
knowledge	31	18	25
comprehension	12	44	22
application	42	18	31
analysis	10	0	6
synthesis	0	20	7
evaluation	5	0	9

Table 3
Analysis of true/false questions according to Bloom's Taxonomy

Bloom Category	Skill description*	Average Result
knowledge	Criticism of company literature Counselling Selecting appropriate treatment Combating polypharmacy Medical literacy Interpretation of drug levels Using prescribing guidelines	77%
comprehension	Criticism of company literature Counselling Selecting appropriate treatment Medical literacy Adverse drug reaction	83%
application	Counselling Using prescribing guidelines Selecting appropriate treatment Combating polypharmacy Interpretation of drug levels Adverse drug reaction	64%
analysis	Criticism of company literature Using prescribing guidelines Interpretation of drug levels	64%
evaluation	Selecting appropriate treatment Adverse drug reaction	43%

*Details of the pharmacology topic within each skill can be found in Harries et al.2006

Table 4 Analysis of short answer questions according to Bloom's taxonomy

Bloom Domain	Skill description*	Average Result
knowledge	Adverse drug reactions	36.9%
comprehension	Adverse drug reactions Medical literacy	20.9%
application	Selecting appropriate treatment Counselling	30.7%
synthesis	Selecting appropriate treatment Dosage calculation	16.6%

*Details of the pharmacology topic within each skill can be found in Harries et al.2006

Table 5 Students' perception of problems contributing to student lack of confidence

Node	Coding profile				Example of student comment
	Number of characters coded	Number of students' documents coded	Number of paragraphs coded	Number of passages coded	
Insufficient coverage	338	3 students 4,5,9	3	3	"Obviously we haven't done as much pharmacology as we should"
Lack of focus on treatment in PBL cases	845	3 students 3,4,8	3	3	"by the time you get to treatment it's a quick add-on"
Lack of basic science knowledge	956	3 students 1,3,9	3	6	"I think also what we needed was the basic back to receptors, back to physiology how does this drug work so once you know the physiology the side effects comes easy instead of trying to learn a list and not remembering half the time what it interacts with
Gap between theory and practice	1089	2 students 1,4	10	2	"We go to hospitals in this clinical methods course and its actually necessary for you to know basic information about antibiotics and analgesics and most of our cases we didn't"
Lack of prescribing strategy	1819	5 students 3,4,5,6,8	15	5	"it's very different when you've got one drug and you've got another drug and you've actually got to prescribe"
Lack of knowledge about drug dosage	2017	4 students 2,3,6,10	5	5	"if you've (a treatment) for example, I would know sometimes drug I would know it's used for what but the thing is usually we don't address…dose, we don't know much about dose because I mean we don't usually, we're not usually taught the dose so .. I think more lectures will be, will have to be on the dose, we have to know the dose"

Table 6 **Outcome Space for Student Conceptions of Prescribing for a patient with uncontrolled asthma**

I Sees prescribing as giving medicines to treat symptoms (1 student)
II Sees prescribing as choosing medicines to treat severity of disease (2 students)
III Sees prescribing as choosing suitable medicines to treat level of disease (5 students) **a** ***Negative aspects considered*** (2 students) **b** ***Making sure patient is able to take medicine*** (2 students) **ab** ***Both considered*** (1 student)
IV Sees prescribing as choosing suitable treatment to treat cause (1 student)
V Sees prescribing as involving patient in the management of her disease (1 student)

Table 7 **Outcome Space for Student Conceptions of Prescribing for a patient with otitis media**

I Sees prescribing as treating the disease (2 students) Student 1: "ear drops that's what most ENT people use as treatment for middle ear infection" Students 9: "use antibiotics, analgesics and grommets"
II Sees prescribing as preventing complications (1 student) Student 10: "I'd give her penicillin because it's the strongest that's what I think and in case and so it doesn't become suppurative or chronic or doesn't erode into her meninges or cause complications…"
III Sees prescribing as killing causative organism (4 students) Student 8: "I'll suspect a common organism… I could take a sample and send it for testing" Student 2: "..Specimen for laboratory as well as microscopy but the organism is considered properly" Student 3: "One of the common ones is Augmentin® and I'm not sure whether that covers.." Student 7: "depends on the organism"
IV Sees prescribing as selecting a drug to kill causative organism in relation to severity of disease (3 students) Student 6: "using the scope you can just check for the membrane whether it's perforated or not perforated Student 4: "if it's otitis media and it's not chronic then the ear won't be perforated" Student 5: "if the ear is oozing, if there is no discharge coming out of the ear, well I would give her antibiotics to cover the organisms…ask the mother to mop the ear…"