Teaching and learning clinical skills : mastering the art of medicine

Teaching and Learning Clinical Skills

Mastering the Art of Medicine

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"The whole art of medicine is in observation,
as the old motto goes,
but to educate the eye to see,
the ear to hear,
and the finger to feel takes time.

And to make a beginning,
to start a man on the right path,
is all that we can do.

We expect too much of the student
and we try to teach him too much.

Give him good methods
and a proper point of view,
and all other things will be added as his experience grows."

Sir William Osler 1849 - 1919

CHAPTER 1

General Introduction

Preface

This thesis will focus on teaching and learning clinical skills. History taking and physical examination skills are crucial skills for every medical doctor in every domain of health care. In fact, despite current technologically advanced diagnostic tests doctors still make diagnoses based on history taking and physical examination alone. Clinical skills remain invaluable diagnostic tools.

This chapter will introduce the research questions of the PhD thesis. First, it will provide an overview of the role of clinical skills in the daily work of medical doctors; it will start with defining what clinical skills are and how they are used in medical practice. The importance of clinical skills in diagnosing and caring for patients in primary and secondary care will be highlighted. Subsequently, this introduction will take a broader perspective and review how skills in the widest sense of the term are learned from an educational psychological perspective. Then we will zoom back in on skills in the field of medicine and discuss how medical schools address skills training in their curriculum and assess these. Lastly, this introduction will conclude with the rationale for this PhD thesis and an outline of the studies done.

What are clinical skills?

There is no set definition for clinical skills in the educational literature[1], although a recent review identified the topic as the second most prominent theme in medical education research.[2]
The Scottish Clinical Skills Network defines clinical skills as follows:
"any action performed by staff involved in direct patient care, which impacts on clinical outcome in a measurable way. These include:
- Cognitive or 'thinking' skills (such as reasoning and decision making);
- Non-technical skills (such as team-working and communication);
- Technical skills (such as clinical examination and invasive procedures)." [3]

For the sake of clarity, this thesis will primarily focus on the third part of this definition and especially the examination skills. That raises the question of what exactly is the definition of examination in this context?
Mosby's Medical and Nursing Dictionary provides the following meaning:
"*an investigation of the body to determine its state of health using any or all of the techniques of inspection, palpation, percussion, auscultation and smell."* [4]

Differences in nomenclature exist in the literature and as a result many synonyms are used interchangeably throughout this thesis. A recently published overview of the history of examination texts lists textbook titles used in the past century.[5]
It shows the variation in terms: 'bedside diagnostic examination', 'physical diagnosis', 'clinical methods', 'examination of the patient', 'diagnostic methods of examination' and 'clinical exam'.

Even though the actual idiom differs, there seems to be a tacit understanding within the medical profession as to what constitutes a physical examination. Phoon argues eloquently that the boundaries of physical examination are not entirely clear, and provides examples to show the difference with 'testing'.
"For example, using the stethoscope is traditionally part of the physical examination. In assessing vision, even using an ophthalmoscope or more sophisticated equipment to enhance the senses—lenses and slit lamps—is still considered physical examination of the eye. But something like echocardiography, the ultrasound examination of the heart, is considered 'testing', because it does not enhance the senses but rather, converts reflected sound waves into decipherable images. The degree of invasiveness also seems to distinguish physical examination from testing. For example, few would argue that colonoscopy is a test, although it enhances the senses much like ophthalmoscopy; but it is invasive and is not used in the routine, day-to-day assessment of patients." [6]
For the purpose of this thesis, physical examination is primarily performed with one's senses with the understanding that these can be enhanced by using non-invasive tools (for example, the stethoscope and reflex hammer).
The use of these skills date back thousands of years.[7] Observation almost certainly was performed in the prehistoric times, but the earliest documentation of the use of physical examination stems from ancient civilizations in China, Egypt, India and Mesopotamia. For example, the principles of cardiac auscultation were first described 4,500 years ago; long before the invention of the stethoscope in 1816. A detailed account of the history and function of physical examination skills falls outside the scope of this introduction.*[1]One historical quote seems appropriate to highlight. William Osler, also called the 'father of modern medicine' advised his students almost 100 years ago as follows: "*Use your five senses. Learn to see, learn to hear, learn to feel, learn to smell, and know that by practice alone you can become expert."* [10]

[1*]Footnote: Interestingly, the technique of percussive diagnosis had its origins in testing the level of wine in casks.[8,9] In vino veritas.

The following sections will clarify why it is important that students learn to use their senses and how practice makes them an expert.

Why are clinical skills important?

The statement that clinical skills are important appears axiomatic. Indeed, the stethoscope is so central to our portrayal of a physician that its value seems self-evident. Performing a physical examination has been likened to a ritual – with similarly profound therapeutic and symbolic value.[11] It seems such a fundamental part of the physician – patient interaction that its significance is rarely questioned. However, there are good reasons why medical students need to learn clinical skills and it is worthwhile to review them here.
Kugler and Verghese list the following five:

1. *"There are many diagnoses that can and always will be readily be made by the physical exam.*
2. *As a hypothesis-generating tool by finding physical signs that one can think of as phenotypic markers for disease.*
3. *When done with some skill, [physical examination] should allow physicians to ask better questions of the tests they order and be judicious in the ordering of tests.*
4. *The bedside exam is a true ritual, and the extraordinary act of the patient disrobing and allowing touch requires in turn that the physician enter this ritual with all the skills needed to be worthy of this trust.*
5. *Medical students have to take a national 'clinical skills' exam and for that purpose at least they must know how to go through the motions."* [12]

It is meaningful to discuss the role of physical examination in the daily work of doctors, specifically in the process of physical diagnosis (reasons 1,2 and 3). Emphasis will be on how existing evidence helps to understand the value of physical examination in medical practice. This will be done by comparing the role of clinical skills in primary and secondary care, followed by a discussion of their limitations. Also, the significance of the physical examination in the patient-physician relation will be briefly highlighted (reason 4). The influence of exams on students' learning (reason 5) will be discussed later.

The role of physical examination in the diagnostic process

Investigating the contribution of physical examination and its findings in the process of diagnosing patients would be a topic for a PhD thesis in itself. Therefore, a brief summary of clinical diagnostic reasoning suffices to provide some understanding of these

complex cognitive processes.[13,14] For the aims of this thesis, an elementary understanding of how doctors reach a diagnosis will be essential to comprehend the importance in learning clinical skills.

Diagnostic reasoning

The first step in diagnostic reasoning is data acquisition.[15] This may include the history, findings on physical examination and the results of laboratory testing and medical imaging. The next step is the creation of the 'problem representation'; a mental abstraction of the relevant information of a specific case.[16] This step illustrates the "*transformation of patient-specific details into abstract terms*" (for example, 'same knee' becomes 'monoarticular', 'had problems like this before' becomes 'recurrent').[17] The ability to develop an accurate problem representation differs in novices and experts[18]; clinical experiences with similar patients positively affect the ability to distinguish relevant information.[19] The way previous patient encounters are stored in the memory of a physician (or a resident, or a medical student) either help or hinder the ability to put the problem representation together.[20] Research has shown that expert clinicians use 'illness scripts' – they store and recall knowledge as diseases, conditions or syndromes.[21] These illness scripts are rich with clinically relevant information, but their content varies greatly between individual clinicians and is highly domain-specific.[22]

The characteristics of the diagnoses (defining features) as well as information that is useful for distinguishing from other diagnoses (discriminating features) become 'anchor points' in memory. Using these anchor points, clinicians build a network of links between clinical features and diagnoses.[23] Also called 'semantic relations' these recollections of previous experiences help to increase the physician's ability to recognize subtle but significant differences in similar cases.[24] After the formulation of the problem representation step, experts compare and contrast several relevant hypotheses based on the defining and discriminating features. This illustrates the mental process of searching the various stored illness scripts for the best match.[25]

In the expert physician's mind, this comparing and contrasting takes place in the data-acquisition phase and will provide guidance in questioning the patient and taking the physical examination. As such, the physical examination becomes a purposeful strategy aimed at the search for and recognition of defining and discriminating features of each illness script being considered.[26]

Clinicians familiar with the features of a particular diagnosis (by virtue of previous experiences) will often use non-analytical reasoning. The clinical reasoning of experts in familiar situations seems to rely on direct automatic retrieval based on the memory of an illness script. This is also called 'pattern recognition' and is considered a sign of diagnostic expertise.[27] It is developed through clinical experience.[28]

When presented with a difficult case clinicians approach problems flexibly. They will use both non-analytic (e.g. pattern recognition) and analytic (e.g. hypothetico-deductive) reasoning strategies. Both are effective and often used simultaneously and interactively.[13]

Deliberate analytic reasoning is the primary process used when a case is complex or ill defined, the clinical findings are unusual or the physician has had little clinical experience with the particular disease and its defining and discriminating features. This latter situation occurs frequently in novices, such as residents or medical students.[20,29] They will often employ a hypothetico-deductive strategy that relies on formulating a "*number of hypotheses early in the diagnostic process and using them to guide subsequent collection of data*".[25] The physical examination in such cases will offer the basis for comparison and contrasting the different diagnostic hypotheses. Furthermore, the findings provide opportunity for novices to develop 'mental models' of the typical presentation of a problem (so-called prototypes) as well as variations or atypical presentations.

It may have become clear by now, that the great William Osler was right in saying that "*by practice alone you can become expert*". The aforementioned quote was allegedly preceded by another reflection: "*observe, record, tabulate, communicate. Use your five senses…*" Unintentionally perhaps, this seems a plea for rigorous research and critical appraisal of clinical skills. In the modern era of evidence-based medicine, clinicians aim to apply the best available evidence gained from the scientific method to clinical decision making.[30]

Evidence for the use of physical examination in the diagnostic process

The scientific method for the evaluation of diagnostic tests (such as physical examination) is however behind the advances made in research of therapeutic interventions (such as drugs).[31] The methodology in diagnostic studies is often poorly defined when compared with trial designs for treatment effectiveness.

As with most diagnostic tests, one of the problems in assessing the scientific value of the physical examination is that a diagnosis in medical practice rarely evolves from one abnormal finding in a single test. As discussed before, clinicians use a combination of data to generate diagnostic hypotheses. Palpation of the liver, for example, is much more sensitive when the patient not only complains of pain in the upper abdomen but also has a yellow appearance and a history of intravenous drug use. Thereby, the test characteristics of the physical examination depend on the experience of the examiner. Results of research studies on a group of experienced clinicians cannot simply be applied or extrapolated to medical students or newly graduated doctors.

In conclusion, the scientific evidence for parts of the physical examination is problematic but in practice these skills are rarely used in isolation to reach a diagnosis. Patient history combined with physical findings form the basis for diagnostic reasoning. Moreover, the reliability of findings may vary depending on the examiner's experience. Mindful of these caveats, it seems meaningful to selectively describe the existing evidence that support the role of clinical skills in medical practice.

Importance of Clinical Skills in Primary Care

In some countries, including the Netherlands, general practitioners have a 'gate keeping' role in the health care system. Patients do not have direct access to secondary care; they need a referral from their (primary care) GP to get access to a hospital or a specialist. In such a system, primary care physicians are faced with the challenge to reduce unnecessary diagnostic or therapeutic interventions whilst delivering good care.[32,33] They have to control the danger of under-diagnosis which not only leads to increased mortality and morbidity but also to higher costs.[34,35]

General practitioners solve most patient problems independently, relying on their clinical skills and diagnostic reasoning over the use of supplementary blood tests or medical imaging.[36] Fifty years ago, almost ninety per cent of all diagnoses in primary care were based on a combination of history and clinical examination.[37] Similar studies spanning decades since have shown that the majority of diagnostic and management decisions in general practice are made using these tools.[38,39]

Even though the exact percentages may have lowered in recent years, the physical examination retains its importance as diagnostic instrument. There is ample evidence of the value of physical examination in diagnosing certain conditions in primary care, such as pneumonia[40,41], torn knee ligaments[42], or goiter.[43]

In the diagnosis of other diseases, it seems that physical examination alone has little discriminating power. The findings on physical examination may play a fundamental role however in a GPs decision to refer for further diagnostic work-up, for example in acute meningitis[44], step throat[45] or Parkinson's disease.[46] See box 1 for additional examples.

"If, for example, you recognise that the patient's chest pain is confined to a dermatome and is associated with hyperaesthesia, and if you spot a few early vesicles looking like dew drops on rose petals, you have diagnosed varicella zoster and spared the patient the electrocardiography, measurement of cardiac enzymes, chest radiography, spiral computed tomography, and the use of contrast that might otherwise be inevitable."[47]

"A 7-year old child with fever and complaints of abdominal pain showed no abnormalities by percussion and palpation of the area. As is usual in pediatrics, a full physical exam was performed. Auscultation of the lungs revealed unilateral crackles which lead to the diagnosis of lower lobe pneumonia. By performing a thorough physical we spared a referral to a consulting surgeon, who might have ordered blood tests for infection parameters, diagnostic imaging etc."[48]

"A middle-aged man is being prepared for surgery. He is hemodynamically stable but smells of alcohol (at 10 AM) and has three spider nevi on his upper chest, but no gynecomastia or asterixis. He is obese, and his belly is prominent. By examining for ankle swelling and shifting dullness you can rule out clinically important ascites without the need for laboratory testing (liver enzymes) and diagnostic imaging (abdominal ultrasound)."[49]

Box 1. Examples of the importance of clinical skills in primary and secondary care.

Importance of Clinical Skills in Secondary Care(47–49)

One might be tempted to think that in hospitals where blood tests and medical imaging are easier to obtain and thus more commonly used[50] clinical skills offer no additional benefit. On the contrary; evidence shows that the effectiveness of supplementary test ordering could be improved if clinical skills are used properly.[51]

A carefully conducted physical examination can improve the timeliness of diagnosis and hence quality of care. One observational study of inpatients showed that one in four had previously undiscovered findings upon review of the physical examination.[52] This lead to pivotal changes in diagnosis and treatment plans, including emergency surgical and interventional radiological procedures.

In addition to the role physical examination skills play in the diagnostic process[27,53], there are several more arguments for the importance of these skills in secondary care. In admitted patients, a careful physical examination can provide physicians with valuable information on the clinical condition of the patient. Findings can be used to support clinical management and guide treatment decisions.

For example, presence and degree of anaemia can be estimated by detecting certain findings[54], such as colour tint of the conjunctivae, nail-bed blanching and palmar crease rubor.
Secondly, the bedside examination can assess prognosis and inform patients and physicians on follow-up. In Neurology for example, even if MRI or CT reveal the anatomical sites of disease only the physical exam can tell the functional consequences in terms of motor or sensory loss or cognitive deficit.
Thirdly, physical examination can also be used to monitor the clinical course during or after treatment, for example in the management of diabetic foot where the presence, localization and shape of arterial lesions must to be well-documented.[55,56] Lastly, the physical is central in measuring fitness in otherwise healthy people for sports checks or as a condition of employment (e.g. in the military).
In conclusion, physical examination is a core skill of doctors whether they practice in primary or secondary care.

Importance for patient-physician relationship

In addition to the abovementioned reasons based on the role of examination skills in the diagnostic process, there is one other rationale that has been proposed in justification of the physical examination. This argument revolves around the value of tactile communication during the examination, when the physician touches the patient.[57] It is argued that this is a central part of the patient – physician relationship, and is likened to a vital ritual in medicine.[58] Supporting evidence for this view is limited but conveys the meaning touch has to the doctor (the diagnostic touch) and to the patient (the healing touch). A careful examination has profound meaning for patients, even when done by medical students.[59]

To summarise, there are several reasons why clinical skills are important.
Many diseases are diagnosed by physical examination. Skilled doctors avoid delays and errors in diagnosis and prevent unnecessary testing. This benefits patients most but also leads to more cost-effective care. The reliability of physical examination as a diagnostic test is dependent on the ability of clinicians to perform that particular exam.
As the 'Stanford 25 - An Initiative to Revive the Culture of Bedside Medicine'*[2] notes; "*we do want to be sure that when people write in the chart "reflexes intact" or "cranial*

* The 'Stanford 25' is a group of doctors and researchers based at Stanford University, USA, which has developed a comprehensive training programme for medical students based on 25 essential clinical skills.

nerves intact" or "S1 and S2 heard, no m or g" that it is not a form of fiction, but represents an accurate observation." [60]
After having established the importance of clinical skills for doctors (in training), we will now discuss in more depth how these skills are learned.

How are clinical skills learned?

In order to make rational choices about how to best learn and teach physical examination skills, it is necessary to have an awareness of relevant learning theory. An inclusive review of existing learning theories, emerged from many disciplines including education, psychology, sociology, anthropology and philosophy, falls outside the scope of this thesis. We will focus on theories that are especially relevant to a discussion of physical examinations skills. This section does not attempt to be comprehensive or to provide a formal critique; instead it will form the background to the studies in this thesis. Emphasis will be put on those aspects that are relevant to the research presented in this thesis.

Description of Skill

Although the definition of 'clinical skills' was discussed at the start of this chapter, it is now prudent to broaden the meaning of this term and to concentrate on the term 'skill'. It would be useful if this summary of the theoretical framework could begin with a clear outline of what is meant by the term 'skill'. Unfortunately, as is pointed out in a comprehensive review of psychological research, "*analysts have been struggling with its definition for decades*." [61]
For the purpose of this discussion, skills have four defining characteristics.

1. The concept of skill is complex and includes a combination of cognitive, perceptual and motor processes. This is ultimately derived from Pear's first definition "*skill is the integration of well-adjusted muscular performances*".[62]
2. Execution of skills is importantly dependent on perceptual and motor behaviour. As per 1, with the addition that each component is weighed differently in different a skill. For example, a skilled surgeon relies heavily on motor and perceptual behaviour, whereas the behaviour of a skilled radiologist stems from his perceptual evaluation of medical images and the cognition in his decision-making. The concern in this thesis will be with the skilled performance of 'physical examination' in which perceptual clues are elicited by actions that are coordinated by mind and limb.

3. Skills are learned. This implies that skills can be acquired gradually by training, but also that learners can lack proficiency in a skill. This characteristic conflicts with the dictionary definition of 'skill', namely *"the ability to do something well; expertise."* [63] Welford noted that
4. "*skill is acquired after long training and consists of competent, expert, rapid and accurate performance."* [64] Expertise in this regard is the mere endpoint of a skill-continuum.

In reviewing how skills are learned, it is important to note the paucity of research about learning clinical skills in the context of medical education. There is a lack of published studies in the medical literature on the acquisition of clinical skills. For a better understanding of exactly how skills are learned and medical students begin their training for competence in clinical skills, we rely on evidence from traditional domains such as educational psychology and sociology. In order to understand the essence of this thesis and its research questions a brief introduction of expertise development will be provided. The little available evidence of skills in the context of medical education will be discussed against the backdrop of generic models of expertise development.

Models of Expertise Development

In the multi-stage theory of Fitts and Posner, it is suggested that the learning process is sequential and that learners move through specific phases as they learn. The learner progresses from a cognitive stage (learning what is to be done), through an associative stage (learning how to do it) and finally to an automatisation stage (where it becomes routine).[65] The initial stage of learning is the cognitive stage and requires a high level of concentration and attention. Learners begin to understand the nature of the skill. Students need specific instructions from teachers to help correct their errors in this stage, as they will not yet know how to correct themselves. In the associative stage, the basis of a skill has been established and learned and the learner can start to refine the given skill. This stage requires less concentration than the cognitive stage but still requires a considerable amount of effort. Errors will gradually decrease during this stage. The teacher's role is to provide the learner with additional information focusing on specific actions and point out relevant cues. In the final or autonomous stage, the learner has mastered the skill; performance is with seemingly little effort and few errors. The name 'autonomous' suggests that the skill has become almost automatic and requires little concentration and attention. In this stage the learner will have the awareness to detect and correct errors in performance. The role of teachers is limited to facilitating the learning situation.

A similarly sequential process with defined stages was proposed by the Dreyfus brothers.[66] Their original model proposes that a student passes through five distinct stages: novice, advanced beginner, competent, proficient, and expert. According to this model, learners first master the rules of the skill and then how and when to apply them. As their level of competency increases, they tend to rely less on these rules and can handle more complex situations. Eraut has elaborated on the original model to include key identifiable characteristics.[67]

These models are valuable in this introduction of skills in the medical domain, as they can be used in two ways. Firstly, they provide a definition of acceptable level for the assessment of competence. Secondly, they provide a means of supporting progress in the development of skills. The next section will describe how learners progress through the developmental stages, and what support teachers can provide. Subsequently, the assessment of skills in the medical domain will be discussed followed by some reflections on clinical competence.

Development of Skill – the role of Training and Transfer

Acquisition of expertise requires sustained practice. Ericsson provides evidence from a variety of domains and disciplines (including medicine) that practice or training plays a crucial role in the development of experts.[68,69] He introduced the concept of 'deliberate practice', characterizing training as a highly structured activity explicitly directed at improvement of performance in a particular domain or at a particular skill. Deliberate practice is not mere mindless repetition of a certain task, but a focused approach to training aimed at reaching a well-defined goal. An important concept in this type of learning is 'transfer': carrying learning experiences over from one situation to another.[70] It is important to note, that transfer can take place on several dimensions[71,72]: for example, on the effect of transfer (positive/negative) or on the target situation (near/far). When learning from one situation interferes with learning in another situation, this is called negative transfer. Positive transfer, on the other hand, helps learners perform effectively in situations for which they were not initially trained. In other words, it enables to solve problems learners have never experienced before. In these situations, both 'near transfer' and 'far transfer' are relevant terms. The former refers to transfer of learning when tasks change slightly but remain largely similar. Far transfer happens when learning is applied to related but largely dissimilar tasks, or when transfer is between different settings or contexts. Obviously; education or training strives to facilitate positive transfer while minimizing negative transfer, and to promote far transfer.[73] However, as McKeough points out in the preface of a popular reference book on educational psychology:

"Transfer of learning is universally accepted as the ultimate aim of teaching. However, achieving this goal is one of teaching's most formidable problems." [74]

The following are found to be effective ways for teachers to promote transfer, derived from educational, psychological and sociological research:

- *"Teach subject matter in meaningful rather than rote contexts.*
- *Employ informed instruction: students should understand when and why the learned material is useful.*
- *Teach subject matter in contexts as similar as possible to those in which it will be employed.*
- *Provide opportunities to practice in settings that represent the full range of eventual applications and are spread out over a lengthy period of time rather than combined into a single study session allowing for distributed practice.*
- *Promote positive attitudes toward subject matter, so that students will feel inclined to deal with rather than avoid problems when they are encountered elsewhere."* [75]

Linking these different theoretical perspectives, it becomes sensible to shift the focus back to medical education to examine how clinical skills teaching deals with the concepts of 'expertise development' and 'transfer'.

Teaching and Learning Skills in Medicine – Practical Perspective

Skills in the first half of the 20th century

In the medical domain, the learning and teaching of clinical skills has remained largely unchanged until the beginning of the 20th century. In the early centuries of medical education students were gradually initiated into the secrets of the craft by observing an experienced physician. Students were expected to work alongside their master until they were deemed worthy of the title 'doctor' and could start their own practice. This apprenticeship approach changed during the first half of the twentieth century after Flexner published his reports on the state of medical education in Europe, the US and Canada.[76,77]

New medical curricula were designed to provide students with a solid theoretical foundation. Traditionally, medical education is now divided between a pre-clinical and clinical phase. The former provides students with essential knowledge in the basic sciences (anatomy, physiology, biochemistry, pharmacology and pathology) whereas the latter

covers the fundamentals of clinical medicine. Students are assigned to randomly sequenced rotations in acute-care hospitals or primary care settings. These rotations are specialty-specific (e.g. Internal Medicine, Surgery etc.) and each typically lasts anywhere from several days to a few months.

In the first half of the 20th century, practical medical education served merely as an illustration to the theoretical principles. It was only in the final years of medical training that future doctors encountered the practical components of their profession. Students were introduced to clinical skills during their time on hospital wards: arguably not the most appropriate setting to allow untrained students to practise essential skills. During the 1960s the effectiveness of this traditional approach came increasingly under attack from students and staff. It was argued that clinical skills should be an integral part of the curriculum. Evidence showed that students were not capable of performing clinical skills in their rotations and recent graduates were not proficient in essential skills.[78-82] Students were not prepared adequately in their pre-clinical years, and both students and clinical teachers criticized existing educational models.[83-87] The potential adverse effects on patient safety served as a strong motivator for change. As a response to mounting pressures from students, clinicians and regulatory bodies (e.g. UK's General Medical Council), medical schools revised their curricula to include more clinical skills.[88-90] These overhauls lead many schools to create independent teaching facilities, specifically designated to teach clinical skills to medical students. Several methods and names for these initiatives exists; clinical skills centre, skills laboratories or skills labs.[91,92]

Learning and Teaching Skills in Medicine – Theoretical Perspective

The fundamental principles of teaching clinical skills in skills labs have been proposed by Scherpbier & Metz in a model that combines theory with years of teaching experience.[93] The model describes five phases for clinical skills learning: 1) preparation 2) training 3) practice 4) simulation 5) assessment.

In the preparation phase, students orient themselves on the skill using audio-visual learning resources and written standards. This preparation will normally take place before meeting with a teacher in the training phase. During time-tabled training sessions the skills will be demonstrated by a teacher. For the next step, practice phase, a variety of training formats can be used. Models and manikins can provide a safe and standardized context to learn the technique of a skill. Training with fellow students,

under supervision, allows students to practise with real persons with different characteristics and feelings, who can give feedback about the quality of the interaction.

Phases	Key characteristics
1. Preparation	Become acquainted with skill Conceptualization
2. Training	Verbalize motions First manoeuvres
3. Practice	Stabilisation of performance Generalisation across settings
4. Simulation	Integration of skill with reality Introduce psychosocial aspects
5. Assessment	Feedback (summative/formative) Identify areas for improvement

Box 2. Characteristics of the 'skills lab' model.

The next phase, the simulation phase, students are challenged to use their newly learned skills in a simulated professional context. Simulated patient encounters can provide a realistic and safe environment where students can integrate their skills and knowledge. These doctor – patient encounters also appeal to the affective and communicative components of the skill. The use of this training format enables the implementation of various didactic principles, which can be illustrated as follows;

- Gradual increase in complexity of skills:
    - Learning how to use a stethoscope;
    - Using the stethoscope to take another student's blood pressure;
    - Deciding whether blood pressure should be taken in a specific case;
    - Interpreting the blood pressure of a simulated patient with hypertension
- Gradual increase in complexity and realism of training situations;
- Gradual increase in integration of skills and knowledge, culminating in problem solving in real doctor– patient encounters.

This approach enables students to gradually acquire a beginning of clinical competence and prepares them for encounters with real patients.

The assessment phase of skills teaching serves two purposes; to provide students with feedback on their performance (formative) and to determine whether students have met the appropriate level of competency (summative). Formative assessment can be

done by teachers, peers or clinical supervisors and is intended to help identify areas for improvement. Summative assessment of clinical skills is graded and passing is often a graduation requirement.
The most frequently used method to assess clinical skills is the 'Objective Structured Clinical Examination' [OSCE].[94] It consists of a series of stations, in which students are presented with a specific clinical scenario portrayed by a simulated patient that requires them to apply their knowledge and demonstrate physical examination skills. All aspects are standardized; scoring, case-mix and performance of simulated patients. Research has shown that the OSCE is a valid[95,96] and reliable[97,98] assessment method, and both students[99] and staff[100] find it an acceptable way to assess clinical skills. OSCEs are used as part of national licensure examinations, e.g. the United States Medical Licensing Examinations[101], and board certification procedures.[102]

The proposed 5-phase model for clinical skills teaching has only been used since relatively recently. Although it is tried and tested in practice, empirical verification of the different stages is lacking. The available evidence and limitations are worth highlighting.

Skills Training: current approaches and problems

Several studies have focused on the outcome of using the 5-phase model for clinical skills learning and have comparatively assessed the competence of students taught following this model or in traditional medical schools.[103-106] Based on these studies it can be concluded that teaching clinical skills in skills labs has two major outcomes. Firstly, students are better prepared at the onset of the clinical clerkships.[104,107-112] Secondly, students increase their skills proficiency during the clerkships.[113-115]

These studies focused on measurable behaviour change in students after following a skills lab curriculum, either by actual skill performance in clinical practice or on authentic assessments such as OSCEs. As discussed before, expertise or proficiency in such regard is considered the mere endpoint of what in reality is a skill-continuum. As Adams noted; *"no investigator should have more than a passing interest in behaviour at its asymptote; a scientific understanding of skill must be concerned with all grades of it."* [61] It is unknown however, what characteristics of skills labs lead to these observed outcomes, what possible interactions exist and how these influence skill proficiency. In other words, the emphasis in the literature has been on expertise while disregarding the developmental process leading to that stage.

Existing examples of skills labs in the literature show that current approaches are not well documented and educational methods lack uniformity.[116-119] A number of problems have emerged from this body of research, the most prominent of which are: lack of insight into best strategies to teach skills in skills labs and lack of insight into augmentation of skills during clinical rotations or clerkships.

Lack of insight into best approach to teach skills in skills labs

The previously discussed model by Scherpbier & Metz is deduced from theoretical principles and strengthened with years of teaching practice. Empirical evidence for the best way to interpret the individual steps of their model is lacking, except for the assessment phase, which has garnered massive attention in the literature. Each of the four stages prior is described in rudimentary pedagogical terminology, so that fleshing out the interpretation of the underlying educational principles in actual practice is subjected to practicability rather than proof. Published reports on skills labs using this method predominantly focus on organizational features such as scheduling of physical examination skills in the curriculum, use of mannequins or simulated patients and financial aspects. Current practice lacks evidence as to what instructional method in training sessions is most useful for teaching skills. However, students also learn skills by engaging in a variety of activities either in preparation for or complementary to regular training sessions in skills labs. The evidence about students' preparation for skills training is limited. Existing studies on the strategies employed by students show ambiguous results.[120,121] The extent of students' learning and practising outside timetabled skills lab sessions appears to be limited.[122]

There is some disagreement about the scheduling of physical examination skills in the curriculum: in the preclinical[123,124] or in the clinical[125] phase of the curriculum. Remmen showed that students in medical schools offering longitudinal skills programmes were better prepared for clinical rotations.[108] Others have argued that skills training should be integrated with real life practice[126], and clinical clerkship directors have indicated that the majority of skills should be learned during clerkships.[127]

Lack of insight into augmentation of skills during clinical rotations or clerkships

There is an abundance of research on teaching and learning in clinical rotations[128-130]; yet little is known about the value of these placements in the augmentation of physical examination skills. Over the past twenty years, increasingly more concerns about the effectiveness of clerkships for developing physical examination skills have appeared in the literature.[82,83,86,107] Undergraduate clinical training is perceived as inadequate in terms of consistency of skills taught to medical students and competencies achieved.[131]

Recent graduates still show deficiencies in performing basic clinical skills such as cardiac auscultation.[80,132]
It has become clear that students following a curriculum with an elaborate skills training programme such as skills labs in the pre-clinical phase practise significantly more basic clinical skills during clerkships.[104] This does not however clarify what aspects of the clinical learning environment encourage students to practise skills and what strategies both teachers and students can employ to make these patient experiences more meaningful. Studies of didactic processes during clerkships show that teaching of physical examination skills is often substandard.[113,133,134] Student performance of physical examination skills is unsatisfactory in curricula which rely on clerkships as the main teaching methods for those skills.[114]

One offered explanation for these observed difficulties lies in the transition from the pre-clinical to the clinical phase at the onset of the clerkships. This is a stressful period for many students[135,136] in which they may face problems when they first have to apply their clinical skills in encounters with real patients.[137-140] Students may suffer from anxiety and low confidence in their ability to perform skills in clinical practice.[141] University teachers may not always be aware of these difficulties and as a result might fail to prepare students appropriately for their transition into the clinical reality.[142] The previously discussed transfer of learning might be responsible for the superior performance of students in schools with a skills lab. Such a curriculum prepares students for their clerkships and improves their ability to perform more skills during clerkships thereby increasing their proficiency. Existing research supports the conclusion that skills labs are an effective way to teach students clinical skills. This does not explain how transfer takes place, what factors contribute to learning and how to optimize this process. The limited and conflicting evidence regarding students learning of skills in clerkships leaves an unsatisfactory gap in our knowledge about skill training.

Rationale for thesis

That brings out the rationale for this thesis. Even though we know that clinical skills are important for every competent doctor, current medical education does not provide the necessary means for students to learn them properly. In the preclinical years, some schools introduce students to skills through skills labs. However, the current approaches for teaching in skills labs are not well documented, and current practice lacks insight into students' strategies to learn the skills before they start clinical rotations. Previous research has shown that skills training in skills labs is essential to prepare students for patient encounters, but there is not much known about how these skills are revised

and augmented during clinical rotations. Furthermore, there is little evidence about the most effective approach of skills training before rotations even though many schools have invested in skills labs. There seems to be much heterogeneity when it comes to the way these skills labs are used, and the most effective didactic process remains unclear. Little attention is paid in the literature to skills during the rotations. Studies suggest these rotations are not very effective in providing students with the needed learning experiences to become competent in clinical skills. Furthermore, existing literature fails to explain how skills are best learnt and taught in the hospital. The underlying factors remain unclear.

These observations on existing gaps in the literature and weaknesses in 'explaining how' is not uncommon in medical education research. In recent years, this scientific field has grown substantially.[2,143] However, there are indications that the published results of such research may not be informing educational practice.[144-148]
Some authors argue that this is because the purpose of educational studies lies on description or justification. The former addresses research questions similar to *"what was done"* while justification studies ask *"did it work?".* Most research on clinical skills discussed earlier falls into these categories. Cook et al advocate for more research that focuses on "*how and why did it work"* , i.e. studies with a clarification purpose.[149] The topic of clinical skills, although identified as a relevant and much-studied subject[2], lacks research that focuses on more meaningful outcomes.[144,150,151] Meaningful in the sense that it has practical application, informs practice and will enhance our educational efforts.[152]

Thus, in order to advance the art and science of medical education, in particular our understanding of the process of teaching and learning clinical skills, this thesis will address the following main research questions:
- How do medical students acquire clinical skills?
- How and why do learning and teaching activities influence this process?

Main objectives

The main objective of this thesis was to explore how students acquire clinical skills during their undergraduate medical training programme. In order to investigate how learning and teaching activities influence this process, we focused our studies on several dimensions of students' development.
Firstly, we concentrated on learning skills in the first years of the curriculum by investigating the role of skills teachers during training sessions from the perspective of both

teachers and students (Part I). Secondly, we studied the activities students undertake outside these time-tabled sessions to improve their clinical skills (Part II). Thirdly, we considered the learning process of clinical skills during the clinical rotations (Part III).

Outline of the thesis

Part I: learning and teaching clinical skills in the Skills lab

Chapters One and Two provide a general introduction to the topic of clinical skills teaching and learning. ***Chapter One*** includes an overview of the literature, placing the subsequent chapters in a theoretical framework. ***Chapter Two*** will focus on skills training at the Skills lab Maastricht University to provide the practical context of the studies. Chapters Two, Three and Four focus on how students learn clinical skills in the Skills lab. ***Chapter Three*** will explore student perceptions of effective clinical skills teachers, by asking: what teaching skills do undergraduate medical students consider effective in their acquisition of physical examination skills? ***Chapter Four*** investigates the teachers' perspective of skills training sessions. The research question addressed here is: what qualities, competencies and strategies do teachers view as effective in teaching physical examination skills in undergraduate medical training?

Part II: learning clinical skills outside the Skills lab

In Chapters Five and Six the learning strategies of students outside the time-tabled skills lab sessions will be examined. ***Chapter Five*** uses a mixed-method approach to answer the question: which activities do medical students undertake outside regular training sessions to improve their physical examination skills? It aims to provide insight into the underlying process by focusing on: how much time do they spend on skill practice, what factors influence their practice behaviour and why?
Chapter Six will study one specific learning strategy used, namely deliberate practice, and its effect on the acquisition of skills. Firstly, this study will ask: what aspects of deliberate practice can be identified in the practice behaviour of clinical skills by undergraduate medical students? Secondly, what development can be seen in the use of deliberate practice across different years of study?

Part III: learning and teaching of clinical skills in the hospital

The next two chapters, Chapters seven and eight, will centre on the hospital rotations and the teaching and learning that takes place in this context. ***Chapter Seven*** reviews the existing literature for evidence of the learning of clinical skills. It addresses the

following research question: what factors influence medical students' learning of clinical skills from real patients in workplaces?

Chapter Eight is a qualitative exploration of the teaching and learning during rotations. The research question aimed at clarification of this process is: how do students describe the process of learning clinical skills in the workplace and what conditions affect this?

Finally, in ***Chapter Nine*** the findings from all studies are summarized and discussed. Implications for current educational practice as well as challenges for further research will be discussed.

NOTE: this thesis is based on a collection of separate articles on a related topic. Since every chapter was written with the intention to be read on its own, repetition and overlap between chapters is inevitable.

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CHAPTER 2

Skills Training at Maastricht University

Based on:
Duvivier RJ, Dalen J van, Bartholomeus P, Verwijnen GM, Scherpbier AJJA.
Skills Training
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Lessons from Problem Based Learning. Oxford University Press, 2010.

Developments in clinical skills training

*"Modern medicine, like all scientific teaching is characterised by activity. The student no longer merely watches, listens and memorises; he **does**."*
— Abraham Flexner, 1910

Since the introduction of formal medical education, training in clinical skills has been provided in several ways. In the early centuries of medical education students were gradually initiated into the secrets of the craft by observing an experienced physician. This apprenticeship approach changed during the first half of the twentieth century after Flexner published his report on the state of medical education.[1] New medical curricula were designed to provide students with a solid theoretical foundation. Contrary to Flexner's observation quoted above, practical medical education served merely as an illustration to the theoretical principles. It was only in the final years of medical training that future doctors encountered the practical components of their profession. Students were introduced to clinical skills during their time on hospital wards: arguably not the most appropriate setting to allow untrained students to practise essential skills.[2] During the 1960s the effectiveness of this traditional approach came increasingly under attack from students and staff.
It was argued that clinical skills should be an integral part of the curriculum.

The Skills Lab

Maastricht University established a Faculty of Medicine in 1974. One of the key principles of the curriculum was to encourage students to formulate their own learning goals. Integration of different elements of knowledge was considered very important. This was reflected in the organization of learning. Problem-based Learning (PBL) became the education backbone of the theoretical strand of the curriculum. Students were presented with problems rather than discipline-related factual knowledge. The presentation of multidisciplinary problems served as a preparation for reality.
Early exposure to practical elements of healthcare was another important characteristic of the new medical curriculum. One of the implications of this was the need to prepare students for the practical aspects of their profession. Ways for providing skills training were sought. After ample deliberation an independent unit was set up: the first skills lab to be established in a medical school.

The main reasons for setting up the Skills Lab were:

- A laboratory setting enables the unravelling of complex practical situations ('whole tasks') into simple teachable skills ('part tasks'): the complexity of learning situations can be controlled.
- Students can practise as often as necessary to master a skill and mistakes are acceptable, which is in sharp contrast to training with real patients.[3]
- Clinical skills can be integrated in the curriculum in a longitudinal training programme. Skills training can illustrate theoretical topics. When students sign up for a particular training session, they will be more motivated to study the anatomy of the part of the body they will be examining. This promotes the integration of basic and clinical science knowledge and skills.[4]

Didactic approach to skills training

The Skills Lab offers training in physical examination, laboratory, procedural, and communication skills. Communication skills are addressed in the next chapter. Training in the other types of skills roughly follows a similar didactic approach. In skills training at least four teaching goals can be distinguished:

1. The technique of a skill should be performed correctly.
2. The skill should be performed in interaction with a patient; communication is part of all procedures.
3. Knowledge and skills are integrated.
4. Findings must be correctly interpreted.

A variety of training formats can be used. Models and manikins can provide a safe and standardized context to learn the technique of a skill. Training with fellow students, under supervision, allows students to practise with real persons with different characteristics and feelings, who can give feedback about the quality of the interaction. Simulated patients can provide a realistic context where students can integrate their skills and knowledge in realistic doctor–patient encounters. (Real) patients help students interpret their findings. The use of these training formats enables the implementation of various didactic principles:

- Gradual increase in complexity of skills:
    - Learning how to use a stethoscope;
    - Using the stethoscope to take another student's blood pressure;
    - Deciding whether blood pressure should be taken in a specific case presented by a real or a simulated patient; and
    - Interpreting the blood pressure of a patient with hypertension.

- Gradual increase in complexity and realism of training situations; and
- Gradual increase in integration of skills and knowledge, culminating in problem-solving in real doctor–patient encounters.

This approach enables students to gradually acquire a beginning of clinical competence and prepares them for encounters with real patients. Students develop their abilities by mastering every element of a skill before moving on to the next stage. Additionally, transfer of what is learned is maximized when skills are acquired in a wide variety of different situations.[5] A distinct advantage of the use of models and manikins is the abstraction of reality. Students can concentrate on different technical aspects of a skill before having to deal with interactive aspects. When practising on peers, supervised by a teacher, students will experience what it feels like to undergo a certain examination and learn how to cope. This is an important experience for future professionals, who will have to prepare their patients for examinations. In addition, students discover that a wide range of findings is considered normal. In encounters with simulated patients students learn to integrate knowledge and skills in diagnosing and managing patient problems. At this stage, skill training begins to evolve into the development of initial clinical competence. Clinical competence increases during the most complex type of training offered at the Skills Lab, in which persons with relatively stable dysfunctions contribute to skill training.
If at any stage students have doubt about their level of mastery of a particular skill, they can go back to a less complex practising stage for further practise. This training loop can be repeated until the student is confident enough to proceed to the next stage. By practising in many separate steps and in many different situations students acquire dexterity and flexibility of skill performance.

Training sessions

Students sign up for training sessions via the electronic learning environment. They can choose a moment when training is most appropriate with respect to their learning goals. They can also select a training session with the teacher of their choice. Finally, training is not compulsory: the Skills Lab offers opportunities for training and it is up to the students to decide whether training can contribute to their competence. Although attendance of training sessions is voluntary, the annual skills test, an objective structured clinical examination (OSCE), is compulsory for all students and has consequences for their study progress. The students who decide not to attend a training session are mostly students who have had prior training. A training session typically lasts ninety minutes and is conducted in groups of eight to ten students. The size of the group depends on the level of complexity of the skill, the risk involved (venepuncture on peers),

the intimacy of the skill (chest examination in mixed groups), and the availability of staff and equipment. Students can prepare by studying recommended reading before training sessions. For individual training sessions a variety of training methods is used, from 'trial and error' to 'find the mistake the teacher has built into the demonstration'. However, a typical training session consists of a four-stage process comprising demonstration of the skill by the trainer, explanation of the skill by the trainer, supervised practice, and corrective critique.[6–8]

Intimate examinations

Some specific areas of physical examination, like the pelvic examination, are obviously very intimate. Students can practise these skills on patient instructors because it is ethically questionable to perform these examinations on other students. Male and female patient instructors are carefully selected and trained to guide students through the examination, giving feedback along the way. The procedure during a training session follows a set pattern. One student meets with a patient instructor and a supervising teacher. In a brief preparatory introduction the examination is described and the student's knowledge about the area involved is refreshed. Then the student examines the patient instructor with guidance from the teacher and the patient instructor. Afterwards the patient instructor gives feedback on the technical and the interpersonal aspects of the examination.

Integration within curriculum

The longitudinal skills programme starts in the first week of the first year. It is integrated with the other curricular activities. The theme of the unit in which students participate is the overriding organizing principle of the curriculum. Horizontal integration ensures the relevance of activities to the unit theme. This way, theory and practice go hand in hand, and skills training serves the additional purpose of helping students to understand theoretical concepts and underlying mechanisms. Vertical integration is addressed in the skills curriculum plan. The skills curriculum has its own structure: some topics must be mastered before the student can move on to another one. This organization is intended to enable students to acquire the necessary skills when they are studying the related theoretical knowledge. In practice, this means continuous interaction between theory and practice. In the unit 'blood loss', for example, tutorial group sessions and lectures deal with theory and the concurrent Skills Lab programme addresses the skills of the pelvic examination, rectal examination, urine and faeces analysis, suturing wounds, and infusion therapy.

Apart from the regular, supervised training sessions for which students can sign up, the Skills Lab also offers teacher independent training. Whenever students wish to practise

a particular skill, to maintain mastery or as extra practice, pairs of students can book a room at the Skills Lab with the required training equipment and materials. A special area of the Skills Lab is dedicated to these sessions. They enable students to maintain skills throughout the years and work at their own pace.

Evaluation, quality assessment, and staff training

The skills programme is evaluated annually by students and staff. Questionnaires are used to measure student satisfaction with a unit. Students are asked to judge specific aspects of a unit, including skill training sessions. The head of the Skills Lab meets regularly with student representatives to discuss the results of these evaluations. Teachers can elicit student feedback on specific issues by special questionnaires. The issues concerned usually originate from the Skills Lab teacher training programme. Skills teachers develop their own learning goals in small working groups, check these with their students, and report back on their individual progress.[9] Experts both from within and outside the university are invited to give workshops on various topics. Each staff member has a personal budget that can be used to attend courses or purchase books. Teacher satisfaction and performance are addressed during yearly performance appraisals.

Assessment

Once a year all the students in years 1, 2, and 3 and year 5 are tested on their knowledge and skills. These examinations are standardized according to the OSCE model. Students move through several 'stations' in which they are presented with a specific clinical scenario that requires them to apply their knowledge and demonstrate specific skills. Every student is confronted with the same series of tasks and is graded on a standardized scoring scheme. Planning groups responsible for the unit are also responsible for the contents of the stations in this examination. This implies that planning groups and the Skills Lab must collaborate closely on this.

Lessons learned

Maastricht University has accumulated more than thirty years of experience in clinical skills teaching. The lessons learned can be summarized as follows.

Longitudinal organization of clinical skills training has a longer lasting effect

Students should be able to relate skills to their prior knowledge and experience. A useful approach to clinical skills training is an iterative revisiting throughout the medical

curriculum. Clinical skills are revisited at different levels of difficulty and new skills are related to previous skills. In addition, teachers frequently refer to underlying principles and clinical relevance when teaching physical examination skills. Young students may have initial difficulties with skills training, but in general it is well appreciated in the early years.[10] Compared to skills acquired in courses that are organized differently, such as a condensed full-time 'introduction to clinical medicine' unit, skills acquired in a longitudinal programme appear to have a longer lasting effect. Thus, skills training should be longitudinally integrated into a helical curriculum organization.[4,11]

Skills training helps students to benefit more from clerkships

When they have attended preclinical skills training students are somewhat skilled when the clerkships start. They feel more confident about their skills[12] and consequently apply more skills compared to students who have not attended a similar skill programme.[13,14] Moreover, students are able to focus more, and better, on pathological findings.

Instructional materials help to standardize training

At the Skills Lab many different teachers moderate the same training sessions. To enhance uniformity of training, sessions are conducted according to a 'standard lesson plan', including didactic guidelines and practical pointers. These are created by the teaching staff. Skills Lab staff members collaborate closely with clinicians of the relevant disciplines in order to contribute to a true 'educational continuum'. The contents of the 'standard lesson plans' have led to a series of instruction books on clinical skills for students. Illustrated with photographs showing the correct procedures, these books now serve as the principal learning resource on clinical skills for Maastricht students. When moving images are needed, video clips are accessible via the electronic learning environment.

Staff must be allocated and trained and their time must be protected

Initially teaching staff from different healthcare backgrounds contributed to skills teaching. These staff members were called upon when and as needed. However, when teaching and healthcare responsibilities are in competition, healthcare inevitably wins. In order to ensure availability of trainers, staff members were appointed specifically to the Skills Lab. Nowadays, most skill teachers have their primary affiliation with the Skills Lab. The Skills Lab teaching staff consists of a small core staff exclusively active in skills training and other staff members who combine their Skills Lab tasks with work in other (clinical or research) settings. Time allocated for Skills Lab work is carefully guarded. It

has proved crucial that all staff assigned to work in the Skills Lab receive appropriate training in the methods used, the objectives of the programme, and how these fit into the overall medical curriculum. Skills Lab staff members, therefore, also assume other teaching roles in the curriculum, such as unit planner, mentor, or tutor of a PBL group.

The Skills Lab must be embedded in the faculty organization

The Skills Lab has full departmental status within the Faculty of Health, Medicine, and Life Sciences. The department head is responsible for the day-to-day management of the Skills Lab. Specific responsibilities are carried out by administrative staff. This setup has the advantage that staff can be appointed on the basis of proven teaching competence. Being a separate department, the Skills Lab is at risk of becoming isolated: the link with clinical departments must continuously be nurtured. This can be accomplished by collaboration in the development of learning materials and training of skills teachers.

Training with peers is beneficial

Physical examination training on peers has proved to be a very useful experience, particularly prior to exposure to simulated patients. It is not only valuable for the student who performs the examination but also for the student who undergoes the examination. More sensitive examinations (such as chest examination) and more invasive procedures (such as venepuncture) need to be handled with discretion and care by students and staff alike. This in itself is a valuable learning experience. Understandably, students initially show some reluctance to participate in this type of training. However, the overall experiences at the Skills Lab are favourable, which is in line with findings described in literature.[15,16] Students from different cultural backgrounds may respond differently to examining (and being examined by) peers. The provision of women-only groups is appreciated by students who might otherwise opt out of clinical examination training on religious or cultural grounds. If students have concerns about this type of training, they can confidentially discuss any personal issues with an advisor appointed by the Skills Lab specifically for this purpose.

Real patients have a valuable role in preclinical skills training

Over the years a bank of real patients has been developed and maintained. These patients have proved to be a valuable asset for the teaching of clinical skills, in addition to simulated patients. Patients with chronic, stable clinical conditions (and their partners!) offer unique learning possibilities.[17] This is especially true when simulation of physical signs and symptoms is difficult or impossible. Moreover, patients can help students to

appreciate the psychological and social impact of their illness. The use of patient encounters in skills training requires careful organization. Real patients, like simulated patients, must be introduced into the curriculum in exactly the same structured and planned way as any other skills training activity. Additionally, patients, like simulated patients, must be trained on how to provide feedback.

Information and communication technology (ICT) can be helpful

Nowadays many sophisticated computerized patient simulators are available, which react to examinations or interventions and can die on demand. The benefits are that students can see and practise procedures at their own pace while the simulator provides feedback. However, caution is needed. Computerized models are often very expensive. Moreover, the validity of the use of these models must be carefully considered. Teachers must avoid teaching 'the delivery of a baby' with a computerized model, test students with that model, and then assume that they are fully prepared to deliver a real baby[18,19] Most feasible are models that allow students to practise, provide feedback, and simulate situations that could otherwise not be simulated. There are many ICT programmes available that help students to (cognitively) prepare for skills training by challenging them to use their prior knowledge.

Research should be the basis for skills training development

Research and development has always been an integral part of the Skills Lab at Maastricht University. Scientific evaluation of existing programmes is carried out to establish and monitor quality and effectiveness. In addition, exploration of new methodologies and assessment techniques guides the development and advancement of clinical skills training as an academic endeavour. The outcomes of research are shared in conference presentations, peer-reviewed publications, and PhD theses. Initially there was not much research into the use of OSCEs for assessment of skills but this gap has been filled by Skills Lab-based research.[20–22] The use of simulated patients has also been extensively researched.[23] Detailed teacher guidelines for adequate skills training have been developed[24,25] and a research project has investigated the actual evidence-base of the skills taught at the Skills Lab. These and other studies have assisted in helping skills training develop beyond intuition into a rational programme.

(International) collaboration helps to update the programme

Skills Lab staff members are often consulted by medical schools abroad that wish to set up skills training facilities. For example, supported by funding from the Dutch government, the Maastricht Skills Lab has facilitated the establishment of skills labs in the

eight medical faculties in Vietnam. Projects like these obviously promote health professions education abroad, but they are also beneficial for the Maastricht programme. Advising other institutions to find solutions to their problems helps the Maastricht Skills Lab to become more creative.[26] Moreover, in today's rapidly changing world, with increased mobility, diversity in the population, pandemics and intercultural interaction, collaboration with institutions in other countries is important to enhance awareness of public health and healthcare issues in other parts of the world. This awareness can help the Skills Lab to adapt its programme to better reflect our current, diverse society.

Future developments

Research projects that have been initiated are planned to continue for some time. Ongoing research focuses on the value of physical examination[27] and the theoretical underpinnings of skills training. Additionally, the use of e-learning in skills training is being explored. Faculty development will continue to be a focus of Skills Lab activities as is continued skills training for vocational training. Some areas, such as interprofessional education and intercultural aspects of healthcare, have not been developed yet, but will be developed in the near future.

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CHAPTER 3

Students' Perspectives on Effective Teaching in the Skills Lab

Based on:

Martens MJC, Duvivier RJ, Verwijnen GM, Dalen J van, Scherpbier AJJA, Van der Vleuten CPM. Student Views on the Effective Teaching of Physical Examination Skills: A Qualitative Study. *Medical Education* 2009; 43: 184-191

Abstract

Objectives

The lack of published studies into effective skills teaching in clinical skills centres inspired this study of student views of the teaching behaviours of skills teachers.

Methods

We organised focus group discussions with students from Years 1–3 of a 6-year undergraduate medical curriculum. A total of 30 randomly selected students, divided into three groups, took part in two sessions. They discussed what teaching skills helped them to acquire physical examination skills.

Results

Students' opinions related to didactic skills, interpersonal and communication skills and preconditions. Students appreciated didactic skills that stimulate deep and active learning. Another significant set of findings referred to teachers' attitudes towards students. Students wanted teachers to be considerate and to take them seriously. This was reflected in student descriptions of positive behaviours, such as: 'responding to students' questions'; 'not exposing students' weaknesses in front of the group', and '[not] putting students in an embarrassing position in skill demonstrations'. They also appreciated enthusiasm in teachers. Important preconditions included: the integration of skills training with basic science teaching; linking of skills training to clinical practice; the presence of clear goals and well-structured sessions; good time management; consistency of teaching, and the appropriate personal appearance of teachers and students.

Conclusions

The teaching skills and behaviours that most facilitate student acquisition of physical examination skills are interpersonal and communication skills, followed by a number of didactic interventions, embedded in several preconditions. Findings related to interpersonal and communication skills are comparable with findings pertaining to the teaching roles of tutors and clinical teachers; however, the didactic skills merit separate attention as teaching skills for use in skills laboratories. The results of this study should be complemented by a study performed in a larger population and a study exploring teachers' views.

Introduction

Much has been written about the role of teachers in medical education and their effective teaching skills. Various roles have been described. It is now generally recognised that medical teachers should act as facilitators of student learning rather than transmitters of knowledge.[1,2]

Since the introduction of problem-based learning (PBL), many studies have addressed the role of the tutor.[3] Research on effective teaching skills points out that, aside from professional knowledge, facilitative and feedback skills[4], a good tutor needs to possess positive personality traits.[5] Wilkerson[6] found that students appreciate tutors who combine student-directedness with guidance, share professional expertise without lecturing, and balance clinical and basic science. Research among medical residents revealed 'knowledgeability' and 'facilitation skills' as important teaching skills.[7]
Outcomes of research by Dolmans et al.[3] on major trends in studies investigating the tutor revealed that a tutor should have content expertise as well as skills to facilitate the learning process.

Effective teaching skills for the clinical teacher have been investigated thoroughly in the past.[8–15] Irby and Papadakis[16] summarised the skills that learners associate with clinical teachers' excellence. Excellent clinical teachers: share a passion for teaching; are clear, organised, accessible, supportive and compassionate; are able to establish rapport, provide direction and feedback; exhibit integrity and respect for others; demonstrate clinical competence; utilise planning and orienting strategies; possess a broad repertoire of teaching methods and scripts; engage in self-evaluation and reflection; draw upon multiple forms of knowledge, and target their teaching to the learners' level of knowledge.

Remarkably little is known about desired teacher behaviour in undergraduate skills training in clinical skills centres (or skills laboratories). Nevertheless, a substantial proportion of the curricula of medical faculties worldwide is devoted to physical examination skills training for undergraduates.[17] Research shows that the setting of skills laboratories differs from that of clinical practice.[18–20]

These descriptions imply that the teaching skills needed by skills teachers in an undergraduate setting may differ from those required by tutors and clinical teachers. As knowledge of the desired didactic qualities of skills teaching in skills laboratories is lacking, we decided to explore students' views of skills teaching based on what is known about tutoring and clinical teaching.

Our research question was: what teaching skills do undergraduate medical students consider effective in their acquisition of physical examination skills?

Context of the study

The 6-year undergraduate medical curriculum at Maastricht University, in the Netherlands, offers a longitudinal skills training programme, delivered in a designated skills training department (Skills Lab). The programme runs throughout the curriculum and is aimed at preparing students for encounters with real patients in Years 3–6.
Training content is based on guidelines developed by Skills Lab staff in collaboration with clinical staff from Maastricht University Medical Centre. The Skills Lab employs 27 part-time teachers selected for their teaching ability and clinical experience. Group sizes per session range from eight to 10 students. Students select sessions that are convenient for themselves in terms of date, time and teacher. Most sessions start with a discussion of students' preparatory reading. Next, the teacher demonstrates the skill using a student, a (simulated) patient or a model, after which students practise on models or one another. Finally, the teacher summarises the session and students can ask questions and give feedback on the session and the teacher's performance.[21–23]

Students are required to pass a mandatory objective structured clinical examination (OSCE) in Years 1, 2, 3 and 5 in order to advance to the next curricular phase.

Methods

Focus group discussions

We organised focus group discussions in accordance with guidelines described by Morgan[24] to explore students' perceptions of effective skills teaching. We used an interview scheme (page 52) based on literature on tutor and clinical teacher behaviour.[1–17] It contained general open questions to be asked in every session, specific open questions, and prompting questions to be asked when elaboration of a topic did not occur spontaneously.

INTERVIEW SCHEME		
1. Spontaneous elaboration questions – overall		
	- What are effective teaching skills in order to be able to perform the examination?	
	- What are effective teaching skills in order to understand the underlying theory of the examination?	
	- What are ineffective teaching skills?	
2. Spontaneous elaboration questions - specific		
- What are effective teaching skills concerning:		
	- handling preparation?	- structure of the training?
	- demonstration?	- balance explaining and demonstration time?
	- handling students questions?	- understanding underlying theory?
	- giving feedback?	- involving all the students?
	- personal conduct of the teacher?	
3. Prompting elaboration questions		
	- Should the teacher identify the groups' initial level of subject knowledge or from every single student?	
	- Should the teacher demonstrate the examination?	
	- Should the teacher refer to literature?	
	- Do you want the teacher to observe you?	
	- Do you want to get positive feedback (do you want the teacher to tell you what you did right)?	
	- Do you want there to be a link with the theory discussed at that moment in the PBL tutorials?	
	- Do you want there to be a link with the underlying anatomy/physiology/pathology?	
	- How much time should there be in a training for you to practice the examination?	
	- How do you want the teacher to answer your questions?	
	- Would you like to have a linkage to the clinical setting?	
	- Would you like the teacher to involve clinical reasoning in the training?	
	- Do you want the teacher make you explaining *why* you are doing something?	
	- Do you want the teacher to stimulate peer feedback?	
	- Do you want the teacher to be strict over basic rules (e.g. dress-code, punctuality)?	
	- Do you want the teacher helping you explore or to explain and demonstrate?	
	- Do you prefer the teacher to teach according to the constructivist or behaviourist style?	

Participants

All 30 randomly selected students, representing 3% of the total student population of Years 1–3, agreed to participate. The group consisted of nine men and 21 women (reflecting the gender distribution in the Maastricht medical student population), with an average age of 20 years. We randomly divided them into three groups of 10 students per group (three Year 1 students, three Year 2 students and four Year 3 students). One student was excluded for not attending the first meeting and one student participated in the first meeting only. Students received financial compensation for participating in the study.

Group moderation

The focus groups were moderated by GMV, an experienced moderator. As head of the Skills Lab, he is familiar with the training programme, but is not a regular teacher.

Format

Six sessions (two per group) were held, each lasting 60–105 minutes. The topics for the first meeting were 'effective teaching skills' and 'specific ineffective teaching skills'. 'Preferred teaching style' and 'negative experiences' were addressed in the second meeting as a result of comments made in the first meetings.

Data collection and analysis

We audiotaped and transcribed the sessions after obtaining consent from all participants. Two researchers (MJCM and JvD) took notes during the sessions. Three coders (MJCM, RJD, JvD) independently coded all student comments using ATLAS Ti software.
The rigour of the qualitative method was enhanced by performing a member check (a discussion that followed every focus group meeting to make minor additions to the topic grid and to set topics for the second meeting), by using independent coding by three researchers and by conducting discussion to develop consensus on any inconsistencies[25] and the predominant emergent themes.

Results

Results are presented according to four predominant emergent themes that were identified from our analysis: didactic skills (preparation, demonstration, answering questions, explanation, feedback, feedback on teaching); interpersonal and communication

skills (attitude and behaviour towards students, enthusiasm); preconditions (integration in the curriculum, structure, preparation by the teacher, time management), and the impact of negative experiences. Didactic skills, interpersonal and communication skills, and preconditions are listed in Table 1.

Table 1. Effective teaching for skills teachers

Didactic skills

Teachers should:

- Discuss students' preparatory reading in a constructive, non-judgemental manner
- Be aware of students' level of knowledge and understanding
- Demonstrate skills step-by-step
- Ask probing questions
- Embed skills training in underlying basic science knowledge
- Help students understand and correct their misstakes
- Stimulate collaboration
- Stimulate contextual learning
- Strike a good balance between questioning and lecturing
- Give constructive positive feedback and explain negative feedback
- Show links between physical examination and clinical practice
- Explain the implications of possible outcomes of physical examination
- Ask for critical feedback on teaching and training sessions

Interpersonal and communication skills

Teachers should:

- Treat students as equals
- Respect students' personal integrity
- Use male rather than female models
- Invite students to volunteer rather than select them
- Show enthusiasm

Conditions of skills training

- Two-way integration of skills training with concurrent curricular components
- Structured training sessions
- Delivery of a summary at the end of a training session
- Sufficient knowledge of the subject on the part of the teacher
- Proper preparation for the training session on the part of the teacher
- Good time management of a session

Didactic skills

Preparation
Students perceived that discussion of their preparatory reading stimulates to consider underlying theory and enables them to compare themselves with their fellow students. Some students wanted to be 'talked through' the examination with notes on the whiteboard; others wanted the teacher to ask (probing) questions but not to penalise for wrong answers (*"It should be training, not an oral exam*"), although some approved of critical questions *("because I think it is good that you are confronted with the knowledge you need to have; it does stimulate you to learn*").
Teachers who demonstrated overly high expectations were seen as potentially problematic and students wanted the recommended preparatory reading to be realistic in terms of quantity and content.

Demonstration
Students wanted teachers to demonstrate a skill *"first step-by-step, not the whole examination at once, because then you forget*" and to allow time for students to practise and ask questions. Opinions differed about 'demonstration by students'. Students acknowledged that, in student demonstration, student demonstrators can learn a lot, teachers can give direct feedback and the group has an active role in giving feedback and assisting the student, but some students worried about exposure and failure in front of the group. There was agreement that skills should be demonstrated by an expert first: *"I find it important that a teacher always demonstrates the skill and that it is not only demonstrated by students because you can learn it from one another, but I learn a lot more if I am sure that what I see is the right way to do it*."

Answering questions
When students practise in pairs, questions arise. Students thought that teachers should be willing to answer those questions, should take questions seriously and repeat them for the group to hear, and should give positive feedback on good questions. Some students advocated the discussion of good questions within the whole group, but others worried that this might have *"a negative influence on the self-confidence of the student asking the question"*.
Students perceived teachers as facilitating the application of theory and transfer of knowledge when students were guided in correcting misconceptions: *"it is important that* [when something is not understood, the teacher] *does not take over but helps to find out exactly what has gone wrong and what the misunderstanding is. "* However, sometimes clear, short answers suffice: *"when you are practicing the whole examination and you don't know one small fact, a teacher should provide this."* Students believed that when teachers are unable to answer a question, they should say so and

suggest a reference instead. Downgrading questions and blaming students for not knowing the answer was not considered acceptable and was thought to discourage students from asking questions.

Explanation
Students disagreed about whether training should focus exclusively on physical examination techniques or whether it should be linked to history taking and basic science. Students who preferred the former described it as their only opportunity to systematically practise a skill and get proper feedback (*"What a teacher should not do is go too deeply into theory I attend skills training to learn how to perform skills"*), whereas others claimed that the latter option facilitates understanding and recall.

Students who wanted teachers to clarify the principles underlying skills performance reported that effective methods include: asking probing questions; giving cues (pointing students in the right direction); encouraging students to refresh anatomical and physiological knowledge; asking direct questions; engaging all students; avoiding awkward silences; helping students think for themselves "*in a way that the teacher doesn't provide all the information, but makes the students think for themselves"*, and tailoring training to group level. Short lectures were described as counterproductive, because "*then you are only listening a little bit"* and buzz groups (groups discussing a specific question) were believed to be used more *"for social talk than for anything else"*.

Opinions differed about whether teachers should share professional experiences. Students said that giving clinical examples can be useful provided the process does not take up too much training time. Volunteer patients (or a teacher acting as a patient) were appreciated because students claimed that information is better retained when "*you can link it to a person*". Students said that providing links to clinical practice stimulates learning: "*It is much more interesting to learn the background and to know when to use the skill*". Students suggested that these links can be achieved by giving prevalence and incidence rates, showing instruments and focusing on differential diagnosis.

Feedback
Students stated that feedback should preferably be positive and negative feedback should be explained: *"it is better to tell why and what you did wrong and give suggestions for the next time"*.
Students said that using one student's mistake as an example for the group is only acceptable if the mistake is a common one and if an explanation for its use is given to the student in advance. Students perceived that individual feedback, preferably based on observation, gives students time to ask questions and can improve performance, level of preparation and motivation.

Feedback on teaching
Students said they are appreciative when teachers ask for feedback, but worry that negative feedback may negatively influence assessment*: "look, if I really didn't learn anything I would like to tell that* [to the teacher]*, but I don't want to feel that I will have a problem if he or she observes me during the OSCE."* It helps when teachers explicitly invite feedback, stressing that it is separate from assessment. Feedback should be integrated into training sessions: *"I think if somebody really wants feedback, he or she should* plan time for it."

Interpersonal and communication skills

Attitude and behaviour towards students
In general students stressed the importance of good interpersonal and communication skills and expressed overall agreement about what constitutes effective interpersonal and communication skills. Students expressed a desire to be treated as equals (*"which creates a more relaxed atmosphere automatically and* [therefore the training is] *more fun"*) and with consideration. Positive behaviours were described as: demonstrating a friendly attitude which motivates students to do their best; being directive, for instance, by directing questions at individual students (*"if* [the teacher] *just asks a question and waits, students often lean back and are afraid to say something"*); staying calm, and stimulating student autonomy by giving positive feedback and encouraging looks. Negative behaviours included: being authoritarian; being overly strict on details, and using diminutives or an exaggeratedly sweet voice.

Students reported that they expect teachers to demonstrate consideration for their personal integrity when they are practising examinations on one another. They dislike having to sit in their underwear for longer than is necessary or being used as an example of a medical condition: "*a deviant student body is no study material*". Students said they prefer to watch a skill demonstration on a male rather than a female volunteer and feel strongly that participants in demonstrations should be invited to volunteer, rather than selected.

Enthusiasm
Students said that they perceive enthusiastic teachers as being passionate about teaching and that they make it clear that they want "[the student] *to understan*d". They are believed to stimulate students to participate actively, retain information and look things up after training. According to students, enthusiastic teachers explain and demonstrate with flair, look friendly, use other information sources besides textbooks, ask probing questions, give positive feedback, are well prepared and give examples

from personal experience. Students reported their perceptions that lack of enthusiasm is reflected in inflexibility, "*showing irritation* [because of an incorrect answer], *sighing about the quality of a question*" and not answering questions.

Preconditions

Integration in the curriculum
According to students, alignment of skills and basic science teaching can enhance the integration of theory and practice. Physical examination skills and related findings should be incorporated into cases addressed during tutorials. Students also suggested that skills should be explained in an introductory lecture.

Structure
Students said that they want to know how a session is structured, what to expect and what the "*main intended learning outcomes are*". They perceived this information as showing that the teacher is well prepared. Some students felt they would like to be given an overview of the session. A few students worried that using a fixed structure might reduce spontaneity. Students said that receiving a summary of intended learning outcomes and take-home messages at the end of a session helps "*to clarify things again*".

Preparation by the teacher
Students said that teachers must arrive well prepared and on time, know which group of students they are teaching ("*indeed, I once had a teacher who didn't know we were second-year students"*), know which topics are addressed in the curriculum, have adequate subject knowledge, make links to practice and know the latest guidelines. Communication among teachers is also important: *"a good teacher should be part of a good team*". Teachers must know what was discussed in previous sessions and strive for uniformity of training to prevent uncertainty and conflicting messages (*"I think it is important that the intended learning outcomes for* [a specific] *skill are the same with every* [teacher]"; *"often the information teachers give doesn't match"*).

Time management
Students reported that they perceive lack of time to be a particular problem with special tests, which are often left until the end of a session. Students said they find this *"annoying"* and that they want ample time to learn and practise without rushing.

Impact of negative experiences
On the whole, students considered that negative experiences cause relatively little harm: most students said they might try to avoid one or two teachers, although they

would join such teachers if there were no alternative. The immediate consequences are seen as reduced motivation, participation and interest ("*Yes, I lose interest in the subject; I think that is a pity*"). Students reported that they might, as a result, study "*to pass the test*" rather than to gain competence.

Discussion

The most important teaching skills for facilitating student acquisition of physical examination skills are interpersonal and communication skills, which are reflected in teachers' expectations of students, responses to mistakes and lack of knowledge, respect for personal integrity, and enthusiasm for teaching. These are followed by a number of didactic interventions, which include: discussing preparatory reading; being aware of students' level of knowledge and understanding; demonstrating step-by-step processes; asking probing questions; embedding skills training in underlying basic science knowledge; helping students to understand their mistakes; stimulating collaboration; stimulating contextual learning; balancing questioning and lecturing; giving constructive feedback; linking to clinical practice; explaining implications of findings, and asking for critical feedback about teaching. Moreover, these interpersonal, communication and didactic skills need to be embedded in several preconditions, which include: two-way integration of skills training with the curriculum; structured training; the delivery of a summary at the end of a training session; sufficient knowledge on the part of the teacher; adequate preparation by the teacher, and proper time management.

This study emphasises the key role played by effective skills in successful teaching and the fact that interpersonal and communication skills contribute to determining how much students learn.[26–30] These findings pertaining to interpersonal and communication skills are comparable with similar findings in studies investigating tutor and clinical teacher skills.[3–15]
Although the students did not consider the teacher's didactic skills to represent the most important factor in their acquisition of physical examination skills, our findings concerning didactic skills indicate that teaching skills in skills laboratories merit separate attention. This study shows that teachers in the skills laboratory setting require different teaching skills to those of tutors or clinical teachers[3–15]; for example, the skills involved in carrying out a step-by-step demonstration, linking skills material to clinical practice and discussing preparatory reading are important to skills lab teachers.

In general, students report that they prefer deep learning and actively constructing their own knowledge. The PBL environment of Maastricht University may explain this.

Problem-based learning emphasizes the learner's active engagement in his or her learning and allows the student to construct cognitive networks[31–33], which is in line with the student preferences in teaching skills we found.

Despite considerable agreement among students, some topics, mostly related to didactic skills, yielded a variety of views, including issues concerning whether skills are best taught in isolation or in relation to clinical context, whether skills are best demonstrated by teachers or students, whether training should focus exclusively on physical examination techniques or be linked to history taking and basic science, and how much of their clinical experience teachers should use to enliven training sessions.

Different views may partly reflect the different study phases in which our subjects were engaged. As this was not the focus of our study, we recommend further research be carried out on this.

It is interesting that negative experiences have varying, but not lasting, impact. Students reported a negative effect during the session in question but, although they then preferred to avoid the teacher concerned, they were nevertheless prepared to attend a session with the same teacher if no other teacher were available.

Because knowledge about students' perceptions of effective teaching skills and student evaluation has been found to be useful for faculty development[34], the results presented here may improve our understanding of undergraduate skills teaching and contribute towards faculty development.

The applicability of this study may be limited by the fact that the focus groups were moderated by the head of the Skills Lab. However, any bias is likely to be minor because students did not recognise him as a skills teacher. Moreover, the diversity of the experiences reported, which include examples of poor teaching practice, suggest that students were not inhibited in giving judgements.

Although the comparability of the results of the three groups suggests that saturation was reached and our findings are in line with other reports of preferred tutor or clinical teacher behaviour, further qualitative research is necessary to establish whether the results can be generalised.

Our study focused on student perceptions of effective teaching skills. To gain more insight into possible incongruences between students' and teachers' perceptions of what constitute effective teaching skills, further studies should examine teachers'

points of view. However, skills teachers can use the insights presented in this study to tailor their approaches to fulfilling students' needs. The effects of this should also be subject of further study.

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CHAPTER 4

Teachers' Perspectives on Effective Teaching in the Skills Lab

Based on:

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Abstract

Introduction

Clinical skills centres (or skills labs) prepare students for patient-encounters. Evidence on teaching skills in these centres is lacking. What teaching skills do teachers view as effective in supporting the acquisition of physical examination skills in undergraduate medical training?

Method

Structured interviews of 10 teachers (1/3 of staff of Maastricht University, Skills lab) were conducted. Selection was based on even representation of age, years teaching experience, gender and previous experience at Maastricht University. A topic grid was used to ensure comparability. Interviews (average 70 min, range 33–95 min) were recorded and transcripts were analysed independently by two researchers.

Results

Teaching skills identified include the ability to adapt content of the training, level of depth and teaching method according to the needs of any particular group. Thorough comprehension of students' context (level of knowledge, prior experience and insight into the curriculum) is considered helpful. Explicitly inviting students to ask questions and providing relevant literature is seen to stimulate learning. Providing constructive feedback is essential, as is linking physical examination skills training to clinical situations. The ideal attitude includes appropriate dress and behaviour, as well as the use of humour.
Affinity for teaching is regarded as the most important reason to work as a teacher.

Conclusion

Desired characteristics for undergraduate skills teachers resemble findings in other teaching roles. Affinity for teaching and flexibility in teaching methods are novel findings.

Introduction

Over the past decades, clinical skills centres (or skills laboratories) have been introduced as specifically designed and designated educational facilities to prepare medical students in a safe environment for patient-encounters.[1,2] Several types of skills are taught in these centres, ranging from communication skills to physical examination skills.

Clinical skills centres complement the theoretical strand of the curriculum and precede the practical phase of clinical rotations. As such, the educational orientation of the clinical skills centre along the continuum of undergraduate education is ambiguous: not quite PBL, not quite bedside teaching.

These clinical skills trainings typically use a rather conventional instructional format. It involves a fairly teacher-centred approach, with the teacher demonstrating the physical examination and students practising with models, each other and (simulated) patients under their guidance.[3]

It appears that this type of education is based on a behaviourist approach to teaching and learning[4,5]; this contrasts modern approaches that typically rely on constructivist notions, such as PBL.[6]

This implies that teachers teaching physical examination skills potentially rely on other qualities competencies and strategies than PBL-tutors. Although much research has been conducted on effective teaching skills for teachers in different settings, most studies on teaching clinical skills addressed teachers in the clinical workplace. Irby and colleagues identified seven features of excellent clinical teaching[7-10]: (1) knowledge and analytic ability; (2) organization and clarity of presentation; (3) enthusiasm and stimulation of interest; (4) group interaction skills; (5) clinical supervision skills; (6) clinical competence; and (7) professionalism.

Further studies by Skeff and his co-workers combined Irby's findings with general learning theories in order to develop an educational framework for clinical teacher behaviours.[11-14]

The few studies on teaching in skills laboratory limited themselves to investigating satisfaction amongst students and staff[15,16]; we therefore formulated the following research questions:

– What qualities, competencies and strategies do teachers view as effective in teaching physical examination skills in undergraduate medical training?

– To what extent resemble these findings effective teaching qualities, competencies and strategies in other teaching roles, such as clinical preceptors and PBL-tutors?

We conducted a qualitative study by interviewing clinical skills teachers.

Context of the study

The study was carried out at the Skills Lab of the Faculty of Health, Medicine and Life Sciences at Maastricht University. A considerable part of the 6-year medical curriculum consists of skills training. The curriculum in the first 3 years is organized in blocks, 6–10 week periods in which certain groups of patient problems or complaints are studied in PBL tutorials. The skills training in these blocks address skills that are relevant for these particular types of complaints and take place at the Skills lab, a specialized educational facility.[16]

A skills training session for undergraduates (year 1–3) consists of a four-stage process involving tutor demonstration, followed by explanation, practice under supervision with feedback and corrective critique.[3,18] Students are provided with preparatory reading material. The main objective of these training sessions is to prepare medical students systematically and gradually, under controlled circumstances for their clinical encounters with patients. Content of the training is fixed and staff meetings aim to achieve educational convergence. Physical examination 'standard lesson plans' are created by teaching staff (in consultation with clinicians) and skills are taught accordingly. The Skills Lab houses 27 part-time teachers. They are recruited on basis of their motivation for teaching and their clinical experience.

Methods

We chose to use qualitative research methods to explore teachers' views on effective and desired teaching skills in order to elicit a wide variety of opinions. To allow maximum freedom to express opinions, individual structured interviews were chosen. This way, interference of group dynamics and interaction between different staff members with research outcomes was kept minimal. To ensure comparability, we constructed a grid with relevant topics based on educational literature.(9,19) This grid was discussed by experts before we finalized the definitive version.[20] See Table 1.

We made a maximum-variation sample until saturation was reached.[21] We interviewed 10 Skills Lab teachers (one-third of the staff): one male and nine female reflecting the gender distribution in our staff. The most experienced teacher started working at the Skills Lab in 1987 (21 years of experience); the least experience joined the staff 4 months before the interview was held. This represents the distribution in our staff. We assumed that more than 5 years of teaching in the Skills Lab warrants the qualification 'experienced': we will use this criterion in the 'Results' section. Neither incentives were used, nor was there any mention of adverse consequences in case of refusal to partici-

pate. Interviews lasted on average 70 min (range 33–95 min), and were recorded on audio equipment with the consent of all interviewees. The interviews were conducted by the principal investigator (RD). The topic grid was used as a guideline to ensure comparability of the interviews. A second researcher (JvD) observed and made notes during the sessions. When considered necessary the observer interrupted and asked additional questions. After each interview we reflected on the data collected and compared field notes; this led to minor additions to the topic grid. Transcripts of the interviews were coded independently by two coders (RD and JvD) using AtlasTi Software and analysed by emergent themes. Central principle in our approach was constant comparison: issues of interest in the data were compared for similarities and differences. We discussed this process afterwards and reached consensus on inconsistencies.[22] For the sake of reflexivity we feel we need to report that the principal investigator RD is a medical student. In order to prevent bias (based on RDs prior assumptions and experiences that might have shaped the data collection and analysis) we adopted the iterative process described earlier.

Table 1. Interview scheme.

(1) Spontaneous elaboration questions – overall – What are effective teaching skills for teaching clinical skills? – What are effective teaching skills in order to understand the underlying theory of physical examination? – What are ineffective teaching skills in this regard? (2) Spontaneous elaboration questions – specific – What are effective teaching skills concerning: – handling student preparation? – structure of the training? – demonstration of the skill? – balancing explanation and demonstration time? – handling student's questions? – conveying underlying theory? – providing feedback? – involving all the students? (3) Prompting elaboration questions – Should the teacher identify the groups' prior knowledge or from every single student? How should s/he do that? – Should the teacher demonstrate the examination? How should s/he do that? – Should the teacher refer to literature? How? – Do you think the teacher should observe every student? How? – How do you think the teacher should provide feedback? When? – Do you want the teacher to provide a link between the skill and the theory discussed at that moment in the PBL tutorials? How would you do that? – Do you want a link to be established between the skill and the underlying anatomy/fysiology/pathology? How would you do that? – How should students practise the examination? – How do you think teachers should answer questions? – Do you think teachers should be able to provide linkage to the clinical setting? How? When? – Do you think teachers should address clinical reasoning in the training? How? – Do you think teachers should explain why a skill test should be performed? – Do you think teachers should stimulate peer feedback? How? – If you consider these two extremes, where would you rate your own position: a teacher who helps students to explore or a teacher who explains and demonstrates? Why?

Results

We present the diversity of perspectives among research participants, including an interpretation that incorporates these variabilities. We will present our findings in categories based on an educational framework used to assess clinical teacher behaviour and modified to fit the setting of this study.[11]

The learning climate: ambiance of teaching interaction

Strategy of addressing students

All teachers agreed on an ideal attitude that allows students to ask questions, without feeling any threshold. This can be achieved by being on first-name terms, and giving a short personal introduction at the beginning of the training. One teacher added the need to let students introduce themselves, since they are not always acquainted with each other. Other examples mentioned to enhance the open atmosphere were making jokes, although caution need to be exercised according to some. Interviewee A: "*We are not hired as stand-up comedians."* Some teachers identify distinction between the styles used in Year 3 as compared to Year 1. Third-year students are regarded as closer to becoming a colleague and are able to understand medically-related inside jokes whereas first-year students need a more stringent approach, according to some.

Quality to keep enthusiasm

All interviewees regarded passion for teaching as the single most important reason to work as a teacher. Interviewee B: *"To show them how well our body is constructed makes me happy."* However, they reported several challenges in maintaining their enthusiasm. Some mentioned lack of expertise or interest in a given subject, whereas others indicated lack of students' commitment or enthusiasm as frustrating. Furthermore, some teachers experience dissatisfaction in the lack of insight into long-term effects of their training. On the other hand, experiencing students' enthusiasm and interaction
first hand makes teaching worthwhile for most of the staff.

Relatively inexperienced teachers reported more often to be too engrossed in conducting a session properly to actively gain enthusiasm from interacting with students. This allegedly develops over the course of several trainings, once they feel more confident and rise above the initial habituation. Interviewee C: "*In the first few trainings…I can't put energy in the students, since I am too busy with myself. I have to invest in my own development first."*

Control of session: the ability to manage, focus and pace the teaching encounter

Preparation by the teacher: competency
The majority of teachers report to use the 'standard lesson plans' when giving a training for the first time. Assisting an experienced colleague in order to copy their working method is another technique mentioned. More experienced teachers described to adapt these standard protocols to suit their preferences or to respond to students' needs. Interviewee D: *"The protocols don't really fit my teaching style; I'd rather deviate from them."* Interviewee B: *"It's good to have some reference to start with, but I always adjust them later on."*
Other methods of preparation mentioned include reading one's own notes on earlier trainings (i.e. common questions), consulting colleagues (especially experts in a given field) or textbooks.

Strategies to handle students' preparation
Most teachers indicated students' preparation should be discussed at the beginning of every training session, mainly to establish an overview of the level of students' knowledge at entry of the training.
The main reason for this is that they want to respond to the level of understanding in later stages of the training session, and to be able to anticipate possible problems that might arise. Interviewee E: *"I just want to know who* [what kind of students] *I am dealing with."*
Teachers acknowledged the difficulty of checking the level of depth that students have reached when preparing for a training session, but stated they regarded this check very important. Interviewee A: *"It's not enough to know whether he/she flipped through an anatomy book or attended a dissection course; I want to get a clear idea whether he/she got it and understands the matter."*

Interviewees indicated that they intend to adapt the content of the training, the level of depth and their teaching method to the needs of that particular group. Teachers mentioned they encounter most difficulties when teaching a group with a heterogeneous level of proficiency. Interviewee B: *"I find this very complicated; you don't want well-prepared students to get bored. They have to be stimulated, while at the same time the less-prepared students need to be attended to as well. You have to know how to give and take a bit. After all you don't want to compromise on quality to help out ill-prepared students at the expense of their well-prepared counterparts."*

A number of teachers expressed their concerns about the expected level of students' preparation, especially with regards to first-year students. Interviewee F: *"Students throw in the towel, and quit preparing altogether. We might be aiming too high; we*

should try to have realistic expectations. Mind you; these students just finished secondary education."

Most experienced teachers pointed out the use of a variety of didactical 'tricks' in order to make this part of the training session more enjoyable for the students, such as a small quiz or a game. A number of consequences of ill-prepared students were mentioned; most notably the effect on the level of profundity of the training session (which is lowered) and their own motivation to teach the students (which plummets). One way to remediate the value of such a session is to advise students to go through the preparatory advice after the training. This way they expect the students to have gained some level of knowledge during the training session itself, which can be raised substantially by reading up on the theoretical background afterwards.
In the event of a group with well-prepared students, teachers show greater motivation to teach. They find this more challenging, and suspect that students learn more during a training session.

Communication of goals: expectations and outcomes

Competency to ensure horizontal integration
Most teachers find it important to have a certain level of insight into other educational activities in order to be able to relate to this in their training. They can thus answer students' questions and have a realistic view on students' prior knowledge. Few teachers report sufficient insight though, due to lack of time. A number of teachers indicated the benefits of holding multiple positions within the medical faculty. They regard their work outside the Skills lab (i.e. on a course planning board or as a tutor) very valuable in gaining insight into the curriculum. Other strategies to gather information reported include asking colleagues or consulting the electronic learning environment. Teachers holding degrees from other universities reported more difficulties commencing their teaching position than UM-graduates. The influence of the Alma Mater extends beyond practicalities (acronyms and terminology) and can ultimately affect teaching performance.
Interviewee F: *"Having studied in the PBL-environment enables me to understand how students are expected to work and learn."*
Assistance and support from experienced colleagues is highly appreciated.

Understanding and retention: teaching methods used

Strategies for demonstration
Teachers are more inclined to demonstrate complex physical examination skills. Simpler skills are easier and learned by students through immediate practice. Interviewee G: *"When the students can do no harm (to each other), they should start off with practising on each other. They can learn how to dot the Is and cross the Ts later."* A much-heard method to maximize students' learning herein is to provide them with a specific learning goal, or a directional instruction. This way students will reach a higher level of understanding; they go beyond simply following the act.
The majority of teachers said to exercise a certain level of reservation in using students as models to demonstrate the skill on. They emphasized to limit the length of time they use with students for demonstration in front of the entire group. They especially noted the need to take great care when students have to undress the upper part of the body. The intimacy and integrity should be guarded at all times.
Several strategies to handle this were mentioned:
– ask for volunteer (preferably male): pay attention to nonverbal signs of discomfort or embarrassment;
– start with practising in pairs/trios: gradual introduction in intimate situation;
– use humour, respectfully and never at expense of individuals.

Teachers valued the fact that students are confronted with feelings accompanying undressing; they view this important for future professionals who will have to ask the same from their patients.

Strategies for linking skills with clinical setting
Teachers mentioned linking physical examination skills training to clinical situations as an effective teaching method. Some think illustrating this relation stimulates interest and motivation during the training, while others explained to aim for a more profound level of knowledge.
All teachers agreed on the main message they want to convey when linking skills to the clinical setting. Interviewee H: *"The ritual trick is not the ultimate goal; you have to be able to detect abnormalities."* Examples mentioned by interviewees are sharing own professional experiences, providing a role-play or written case, asking questions about differential diagnosis.

One other aspect highlighted is the importance of clinical reasoning skills, not only because of clinical relevance but also to improve understanding of the physical examination skills. Some feel this should be taught more intensively, intertwined with the

physical examination skills. Interviewee D: *"I try to let students link what they hear, feel or do with whatever knowledge they already have to make it a bit more inspirational."*

Evaluation and feedback: how to assess learners' achievement of desired goals and how to improve learners' performance

All teachers identified providing feedback as the most important aspect of their role. Individual variations exist in the methods used. The example most frequently mentioned involves asking students to demonstrate the examination skill while explaining the process step-by-step to the teacher. This way, errors in reasoning can be detected and corrected. Most teachers reported to exercise restraint on the amount of explanation they provide. Instead, they try to challenge students by asking provoking questions emphasizing/building on prior knowledge. Additionally, some teachers report to encourage students to structure knowledge avoiding jargon, i.e. to express what they have learned in their own words. Teachers value the pro-active attitude students have to adopt and the fact that they have to actively participate in their learning, as opposed to the more passive approach with the teacher explaining.

When discussing a student's behaviour, most teachers address this on a one-on-one basis or in the working pairs. They are reluctant to provide feedback to an individual student in front of the whole group, due to the disruption this causes and to safeguard personal integrity. As a rule, most teachers said to provide alternatives to incorrect manoeuvres and to discuss reasons with the student. Interviewee I: *"I sometimes ask a student: what do you think your patient feels when you do it this way?"*

Interviewees hold different views on the correct timing of intervention. Some mentioned to intervene whenever they felt necessary, while others reported to do so only on a students' explicit request. All the teachers recognized the importance of making mistakes, and giving the students an opportunity to do so exactly. In practice, this means that they deliberately allow students to make mistakes and find things out themselves. Interviewee E: "*Experience comes from making mistakes; you can learn a lot by walking into a wall."*

Inexperienced teachers reported difficulties in finding the balance between mistakes contributing to the learning experience and unnecessary muddling along. Interviewee J: "*I wonder, to what extent is messing around valuable?"*

The majority of teachers stressed the importance of building on steps/parts already mastered. By focusing on improvements rather than mistakes in students' behaviour they reported that students' motivation and self-confidence remains high. Further-

more, some teachers expect students to achieve competence earlier when given feedback in a constructive manner.
Some teachers described to give assignments in order to give more specific feedback and check individual students' progress on particular parts of the physical examination skill. One example mentioned was marking the lung fields with pencil before percussion of the chest. This way, teachers can provide accurate feedback even in large groups when it is not feasible to observe all students at the same time.

Self-directed learning: enhancing learners' abilities to identify own needs

Strategies to answer questions
Students should be encouraged to ask as many questions as possible; teachers identify this as one of the most powerful learning tools. Most teachers explicitly invite students to ask questions throughout the training by underlining this possibility during the introduction of the training.
Some teachers said to collect (i.e. not immediately answering) questions during the practical part of the training session, especially when they know the questions concern notorious problems, which the majority of students will encounter at some point. They would answer the questions later in a plenary session with the whole group to avoid having to answer the same questions several times. This is only possible when the teacher is familiar with the training; inexperienced teachers did not report this behaviour. A widely used method to answer questions as shared by the teachers is to bounce the question back to the student who asked it. This way, they try to encourage the students to use their knowledge and reasoning skills in order to come up with the right answer themselves. If this proves inadequate, the question can be passed on to other students. Sometimes, connections can be made with earlier trainings on the same subject (in previous years) or other educational activities/ teaching activities available (i.e. anatomy dissection course or lectures).

Teachers justify this technique by referring to increased retention in students' memory. When confronted with a question they do not know the answer to, most teachers will be open about that and tell students so. Although most teachers advice students to use relevant literature in order to find an adequate answer, few teachers will actually themselves look for one after the training. Those who do said such questions provoke their own curiosity.

Asking feedback on own teaching performance

Teachers describe asking for feedback as pivotal in their own learning. Most notably the lesser-experienced teachers regret the lack of feedback from students. Interviewee C: *"It's a real pity; they just say it went 'OK'."*

Peer-feedback is highly appreciated, although only few have experience in asking colleagues with time being the constraining factor. Useful methods include video-taping and real-life observation.

Discussion

Desired qualities, competencies and strategies for undergraduate clinical skills teachers are summarized in Table 2.

This study is the first to address the specialist environment in which these skills teachers operate; the increasingly popular clinical skills centre or Skills lab. We will discuss the outcomes of our study considering this unique setting by contrasting and comparing our results to adjoining teaching roles such as clinical preceptors and PBL-tutors.

Table 2. Teachers' perceptions of desired abilities for skills teaching

Qualities
Attracted to teaching
Sense of humour
Clear idea about limitations in own knowledge
To respect students' limitations without being pejorative
Awareness of responsibility as role-model
Competencies
Thorough comprehension of the level of knowledge and prior experience of students
Knowledge of the curriculum and insight in the educational backgrounds
Strategies
To adapt - the content of the training - the level of depth - the teaching method to the needs of any particular group
Explicitly inviting students to ask questions
Providing feedback on examination skills in a stimulating way
Guard intimacy and integrity by peer physical examination
Emphasize on the wider perspective: the formulation of differential diagnosis and detection of underlying pathology
Stimulate contextual learning by linking physical examination skills training to clinical situations

Qualities

Our findings show that enthusiasm and enjoying teaching are qualities of good teachers. This is in line with findings of residents' perception of their teaching role as well as described rewards for clinical teachers.[23,24] The importance given to these qualities by our sample group marks a distinct difference from studies on other teaching roles, where this was mentioned as a mere side finding. Passion for teaching emerges in our

study as a key characteristic for skills teachers (Irby's enthusiasm and stimulation of interest).

Competencies

Other important themes in our study included preparation of the teacher and educational background. McLean and Van Week identified that, apart from insight into PBL principles, facilitators of tutorial groups should also have working knowledge of different aspects of the curriculum.[25]

Teachers' ability to adapt to varying conditions and to draw on a wide educational repertoire resembles findings in tutors[26,27] and clinical teachers alike[28] (Irby's organization and clarity of presentation).

Novel findings in this regard are the clear distinction between experienced teachers (>5 years of experience) when compared to relatively inexperienced counterparts. The former described to be more able to assess needs of individual students and to adapt their teaching methods accordingly.

New teachers should be provided with support, training and guidance in order to master these techniques. In addition, our findings revealed that teachers value feedback from students and colleagues as it provides direction for improvement in behaviour and skills (Irby's knowledge and analytic ability).

Strategies

With regard to the physical examination skills, good teaching emphasizes not only providing a demonstration but also explaining decisions and encouraging students to reason with clinical information by asking probing questions (Irby's clinical competence and clinical supervision skills).

Furthermore, providing students with feedback is seen as a crucial aspect of teaching. Strategies mentioned by teachers include the use of reflective practice during the actual practice of physical examination skills or directly afterwards. As identified by Schon this method provides important adjuncts to learning.[29]

Stimulating students to think for themselves resembles findings in PBL-tutors where this phenomenon is called 'scaffolding'.[19] It implies that interaction and dialogue between the teacher and the learner or between peers plays a central role (Irby's group interaction skills).

Furthermore, teachers who make effective use of scaffolding make learning an active and constructive process whereby they seek to draw as much as possible out of their students; the Socratic style of teaching.[30] Our findings indicate that teachers aim to develop students' ability to identify their own educational needs and to enable them to take appropriate actions to fulfil these needs. At the same time, our teachers reported

to actively engage students in their learning and to provide meaning and relevance. In other words, they promote self-directed learning by incorporating Knowles' Principles of Adult Learning in their teaching approach.[31]

This approach does not correspond with the described behaviouristic background of skills teaching. A more constructivist method of skills teaching might be more appropriate. This affects both educational setting (e.g. curriculum development) as well as teacher's behaviour (e.g. faculty development). Further research could focus on the effects of using a more student-centred/self-directed learning model for clinical skills teaching on students' learning.

Treating students with respect does not only contribute to their professional development, but also shows them the correct attitudes towards their patients and colleagues.[32,33] This way the teachers can take on role models, although they should be well aware of this responsibility[34,35] (Irby's professionalism).

To summarize, desired qualities, competencies and strategies for undergraduate clinical skills teachers resemble findings in other teaching roles. We found that teachers in clinical skills centres need to adopt the best of two worlds (PBL-tutors and clinical bedside teaching), in order to effectively teach students how to perform physical examination skills.

Although one might question the validity of the findings in this study based on the number of teachers interviewed, a number of circumstances compensate for this. First, we ensured comparability by conducting individual interviews in a structured method based on international literature published on other teaching roles. Second, by allowing for a maximum variation sample we ensured to include as wide a range of perspectives and backgrounds as possible to capture the broadest set of information and opinions. To further strengthen this approach we included outliers on several characteristics (i.e. years of experience, gender, previous experience at Maastricht University as a student) to incorporate a deviant sample.[21]
Of these variables only experience was important to some extent as is addressed earlier. Third, the outcomes of these interviews were coherent in thoroughness between all interviewees so that data saturation has been reached.

To further strengthen the generalizability of our findings triangulation is needed. Future research should focus on possible incongruence between students' and teachers' perception of effective teaching skills. These findings could prove valuable for faculty

development programmes, carried out to improve overall quality of teaching and staff's knowledge and confidence.

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CHAPTER 5

Practicing Clinical Skills Outside Timetabled Skills Lab Sessions

Based on:

Duvivier RJ, Geel K van, Dalen J van, Van der Vleuten CPM, Scherpbier AJJA. Learning Clinical Skills Outside Timetabled Training Sessions.

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Abstract

Introduction

Lack of published studies on students' practice behaviour of physical examination skills outside timetabled training sessions inspired this study into what activities medical students undertake to improve their skills and factors influencing this.

Methods

Six focus groups of a total of 52 students from Years 1–3 using a pre-established interview guide. Interviews were recorded, transcribed and analysed using qualitative methods. The interview guide was based on questionnaire results. Overall response rate for Years 1–3 was 90% (n = 875).

Results

Students report a variety of activities to improve their physical examination skills. On average, students devote 20% of self-study time to skill training with Year 1 students practising significantly more than Year 3 students. Practice patterns shift from just-in-time learning to a longitudinal self-directed approach. Factors influencing this change are assessment methods and simulated/real patients. Learning resources used include textbooks, examination guidelines, scientific articles, the Internet, videos/DVDs and scoring forms from previous OSCEs. Practising skills on fellow students happens at university rooms or at home. Also family and friends were mentioned to help. Simulated/real patients stimulated students to practise of physical examination skills, initially causing confusion and anxiety about skill performance but leading to increased feelings of competence. Difficult or enjoyable skills stimulate students to practise.

Conclusion

The strategies students adopt to master physical examination skills outside timetabled training sessions are self-directed. OSCE assessment does have influence, but learning takes place also when there is no upcoming assessment. Simulated and real patients provide strong incentives to work on skills. Early patient contacts make students feel more prepared for clinical practice.

Introduction

Recent years have seen increasing attention for physical examination skills in the medical curriculum. Pleas from clinicians to restore the art of physical diagnosis as a core competency for students have not gone unheard.[1] In recommendations for changes in the content and delivery of the undergraduate medical curriculum, various bodies have emphasised the importance of physical examination skills and recommended essential skills in which students have to demonstrate competence and proficiency before graduation.[2-4]

All this attention has encouraged many medical schools to revise their curricula to include clinical skills and to establish clinical skill centres to provide appropriate training.[5-7]

There is some disagreement about the scheduling of physical examination skills in the curriculum: in the preclinical[8,9] or in the clinical[10] phase of the undergraduate curriculum. Remmen showed that students in medical schools offering longitudinal skills programmes were better prepared for clinical rotations.[11]

Others have argued that skills training should be integrated with real life practice[12], and clinical clerkship directors have indicated that the majority of skills should be learned during clerkships.[13]

Students appreciate skills training as preparation for future medical practice[14] It also appears to ease the transition from the theoretical phase to the clinical phase of undergraduate medical education.[15,16]

Students learn skills not only during formal training sessions but also by engaging in a variety of activities either in preparation for or complementary to regular training sessions. The existing evidence about students' preparation for skills training is ambiguous. Most studies found that students prepare for training sessions and practise outside timetabled teaching activities. Rudland et al. recently suggested that students mostly practise skills on each other and rehearse routines.[17]

However, a study by Mavis revealed that students who practised for more than 3 hours spent only 20% of that time actually performing skills, while the remaining time was used to review textbooks and class notes.[18]

There is anecdotal support for the hypothesis that students' learning and practising outside timetabled sessions is limited. As much as one-third of students never practise outside training sessions.[19]

The limited and conflicting evidence regarding students self directed activities in skills training leaves an unsatisfactory gap in our knowledge about skill training. In order to increase our understanding, we pose the following research questions:

- Which activities do medical students undertake outside regular training sessions to improve their physical examination skills?
- How much time do they spend on skill practice, what factors influence their practice behaviour and why?

This paper will describe a sequential study with focus group interviews based on questionnaire results.

Methods

Setting

The study was carried out at Maastricht University. Starting in the 1 year, clinical skills training has a prominent place in the six-year problem-based curriculum. Curriculum content in Years 1–3 is delivered in theme-based, six to ten-week blocks. The skills programme runs in parallel with the blocks and its content is aligned with block content. Approximately 125 formal training contact hours for skills are scheduled. Box 1 provides examples of skills addressed. A training session typically lasts ninety minutes and is conducted in groups of eight to ten students. Students can prepare by studying recommended reading before training sessions. A typical training session consists of a four-stage process comprising demonstration of the skill by the teacher, explanation of the skill by the teacher, supervised practice (first on models/manikins, then on peers) and corrective critique.[20]

Years 4–5 consist of clinical rotations and year 6 consists of an 18-week research internship and an 18-week clinical internship in one clinical department. A skills training in these years is mainly focused on refreshing and rehearsing skills, because the essential clinical skills have been addressed during the previous years. The skills training programme is developed, organised and delivered by the Skills Lab, a specialised educational facility.[21]
During the first 3 years students take part in a communication skills programme, consisting of simulated patient encounters and group sessions, in which students provide feedback on the recorded encounters of their peers. Simulated patients are primarily used for teaching communications skills; when students are required to take a physical examination during simulated patient encounters they will have received formal training in the Skills Lab beforehand.[22]
In Year 3, students have real patient encounters on 1 day per week in the community (general practice) or the university hospital. The patient contacts serve as the starting

point for self-study and group discussions, as described in detail elsewhere.[23] Students sit in on consultations, and gradually take on more responsibilities such as history taking and physical examination.
At the end of years 1, 3 and 5 there is a compulsory Objective Structured Clinical Examination (OSCE) Performance is scored on checklists by trained observers. Passing the OSCE is prerequisite for advancing to the next stage of the curriculum.

Sequential study design

We used a sequential study approach with focus groups interviews guided by questionnaire results. This method allows for a broad and possibly superficial collection of themes (statistical analysis of quantitative data) as well as in-depth exploration of experiences (using qualitative focus groups). The questionnaire asked about the amount of time devoted to skill practice and about learning resources used. The results were used to identify important factors to be pursued during the focus group interviews.

Questionnaire

We developed a questionnaire based on the literature and on expert opinions. After piloting among four students (2nd and 3rd Year) and review by four medical education experts (all professors and holding PhDs), some modifications were made. The final questionnaire consisted of thirteen questions and took 10 min to complete. It consisted of two parts: questions about age, sex and year of study, and questions about the amount of time devoted to studying and skill practice (current year only) See appendix 1 for the full questionnaire. Before completing the questionnaire, the participating students received an explanation of the purpose of the questionnaire. Students participated voluntarily and received no compensation.
We approached all students in Years 1–3, because after the third year students no longer attend scheduled skill training sessions. Not all students could be reached: 875 out of 972 completed the questionnaire giving an overall response rate of 90%. The sample comprised 298 first-year students (92% of the Year 1 cohort), 292 second-year students (87% of the Year 2 cohort) and 285 third-year students (90% of that cohort). The data of 45 students who failed to state their year of training were not used in the analysis that considered year of study as a variable. SPSS Software (version 15.0 for MS Windows) was used to analyse the questionnaire data. We calculated mean scores, standard deviations, and performed t-tests to determine significant differences. A p value <0.05 was considered significant.

Focus groups

We used a qualitative approach for in-depth exploration of students' skill training activities, because it can elicit a wide variety of opinions and includes multiple perspectives. We organised focus group interviews in accordance with guidelines described by Morgan.[24] We used an interview scheme based on the results of the questionnaire. It contained general open questions and prompting questions to be asked when elaboration of a topic did not occur spontaneously. Recruitment was done via an e-mail sent to all students of Years 1–3 explaining the purpose and procedure of the study and inviting the students to participate, followed by a reminder e-mail 2 weeks later. Our aim was to collect data until saturation had been reached. We randomly interviewed 52 students (12 male, 40 female) from the total that had responded. We randomly assigned participants to two groups per study year: six groups in total. The participants received a small financial compensation for participating in the study. The participants did not significantly differ in terms of study results from the general student population. Gender distribution was significantly different: 64% of questionnaire respondents were female while 77% of focus group participants were female.

Twelve sessions in total (two per group, two groups per study year 1–3) were held and facilitated by one researcher (AJJAS or JvD). A second researcher (KvG) observed and took notes, interrupting to ask additional questions, if necessary. First sessions lasted 60–70 min. During the second session (20–30 min) the findings of the first session were verified and clarified. The sessions were recorded and transcribed literally. Participants were allowed to review the transcribed sessions and make additions (member check). The transcripts were independently analysed by three researchers (RJD, KvG, JvD). Comments were coded and analysed for emerging themes.

Two of the researchers (RJD and KvG) were medical students. In order to prevent bias (due to preconceptions and experiences that might affect data collection and analysis) we adopted an iterative analytical process. The central approach of the analysis was constant comparison: issues of interest in the data were compared for similarities and differences. The researchers discussed the process afterwards and reached consensus on any inconsistencies.[25]

At the time of study, educational research studies reporting students' opinions did not require approval from the ethics committee at Maastricht University. However, relevant ethical issues were carefully considered by the Department of Educational Research and Development.

Results

We present the results of the quantitative analysis of the questionnaire data, followed by the themes that emerged from the qualitative analysis of the focus group transcripts, with illustrative quotes.
The results are grouped under two categories and several subheadings, providing answers to the questions: how do students practise physical examination skills outside training sessions and what influences these activities?

How do students practise physical examination skills?

The mean age of the respondents was 20.3 years (SD = 1.50 years) and 64% were female. This reflects the overall age and gender distribution in the medical student population of Maastricht University.

Time spent practising skills outside timetabled training sessions
Students reported an average of 17 hours (SD 6.3) per week for self-directed study and 3.4 hours (SD 2.2) for clinical skills practice outside timetabled training sessions. So 20% of time for self study was devoted to skills. Students in Year 3 reported a significantly lower number of hours for clinical skills than their first-year counterparts (2.9 vs. 3.5 hours) (Table 1).

Table 1. Time spent on study-related activities

	Year 1	Year 2	Year 3	Total
Mean number of hours of self study per week	15.6 h(SD 6.3) 68% of total study time	16.4 h(SD 6.4) 71% of total study time	15.8 h(SD 6.2) 65% of total study time	17.0 h(SD 6.3) 72% of total study time
Mean number of hours per week for skills	3.5 h (SD 2.3) 22% of self study time	3.7 h (SD 2.4) 23% of self study time	2.9 h (SD 1.8) 18% of self study time	3.4 h (SD 2.2) 20% of self study time

Learning resources
The focus group sessions revealed six categories of resources used by the participants: textbooks, examination guidelines, scientific articles, the Internet, videos/DVDs and scoring forms from previous OSCEs. Videos (supplied by the university either online or in the library) were considered superior to photographic material, as they showed the actual sequence of the steps being demonstrated. Videos on websites like YouTube

were rarely used, mainly due to doubts concerning their accuracy. Some students mentioned using Wikipedia, especially to get a quick overview of a problem/subject.
"I watched the DVDs quite a lot. You read the guidelines but you are not quite sure what exactly it is you are supposed to do and it is very good to actually see what you have to do. I think there is real added value to that ." (year 2, group 2, student 3).
"*Those DVDs are quite helpful: it is easier than reading about it and you see someone demonstrating the skills."* (year 2, group 2, student 5).

General textbooks were not frequently used by Year 1 students. Students in Year 3 reported using them to link complaint, disease and physical examination. Some students said they only studied the guidelines and never used any other learning resources when practising clinical skills.
Students said they used the scoring forms from previous OSCEs to get an idea of what to expect in the OSCE and to detect any deficiencies in their skills).
"There is so much theory and the question is where to start and then scoring forms are useful, for you do know you have to know all the examinations. But in this way you can see what they are going to ask." (year 2, group 2, student 6).

Location
Students can use university rooms, equipped with all the necessary materials to practise physical examination skills. Some students said they had never used these rooms. As inhibiting factors they mentioned suboptimal materials or out-dated learning resources and having to reserve the room in advance, which they considered cumbersome and inflexible. Most students said they preferred practising in the comfort of their own homes. They thought it was more enjoyable, with all materials (books, videos, Internet, notes) handy and without being restricted to resources and opportunities/times offered by the university. One disadvantage of practising at home was potential distractions, mostly the risk of socialising instead of practising. Some students saw this as an advantage though, especially with more intimate examinations, as it takes away some of the anxiety surrounding them, such as undressing in front of a group of peers.
"It is nicer to be in your underwear with just two girlfriends and to just chat around a bit." (year 2, group 1, student 4 [female student]).

Aids
Students said they practised physical examination skills on: family, fellow students, housemates. The pros and cons of each group were discussed. Using lay people (family, housemates, friends) forces students to be very precise in choosing their words and in

demonstrating an examination. They used more medical jargon and explained less when they were practising with fellow students.
Some students said they instructed their fellow students to pay particular attention to this pitfall, but commented that it did not always work out as a result of unconscious socialisation.
"My friend is a 2 year medical student and it is really easy to practise with him for he can tell me like 'you're doing this the wrong way, you're doing that the wrong way', when I practise with my mother, she is thinking 'oh, you are doing really well, you are just like a real doctor', but she cannot tell me when I get it wrong." (year 1, group 2, student 3).

Fellow students
The main advantage of practising with fellow students is that they can give feedback. Some students mentioned practising with housemates or friends who were senior medical students to get the most useful advice. Peer students were appreciated for their ability to think along when practising and to challenge established patterns. Many students reported feeling uncertain when they were practising without a teacher present. They wished to have more opportunities to practise at the university with an expert available for questions and feedback.
"If you get it wrong there is nobody there to tell you, so you never know if you are getting it right and that is quite frustrating." (year 2, group 2, student 4).
"You may practise abdominal examination but when you do percussion the wrong way there is nobody there to tell you that that's not how it is done" (year 3, group 1, student 6).

Students also valued the opportunity to be examined and to feel the effect of certain procedures: too hard, too soft etc. One student explicitly mentioned practising with a variety of different people in order to get an idea of the differences between real patients.
"I sometimes go to my grandmother. She is very old and that makes such a difference. She thinks it's great. She is 90 years old, so when you listen to her lungs you hear almost nothing because it is all very muted. Or my friend's grandmother. They all have lungs. Everybody has to know what I am studying." (year 1, group 2, student 5).

What influences practising?

Influence of OSCEs
Responses from 1 year students showed that the uncertainty surrounding the OSCE is a strong incentive to practise physical examination skills. In later years students seemed to have become more familiar with the purpose of the exam, but there was still considerable anxiety about the expected level of competence.
Students acknowledged that they should probably start practising earlier in the year, or more regularly, but they cited lack of time and a limited sense of priority as the main reasons for their peak in practising activities just before the OSCE. Some students suggested more tests, perhaps two OSCEs per year, in order to stimulate them to practise.
"The immediate prospect of the OSCE. That you write more down during training. Really much more, yes." (year 1, group 1, student 8).

Influence of simulated and real patients
Simulated patient encounters served as a stimulus to practise for many students, although there was some disagreement about the place of clinical skills other than communication skills in these encounters. Most students considered communication skills more important. Students suggested that better alignment of physical examination skills training sessions with simulated patient encounters would encourage more intensive preparation for the encounters. Students were motivated to prepare for the encounters, as they wanted to give the simulated patient the impression of being professional and well prepared. Some said they also wanted to make a good impression on their peers, who later watch the recorded encounter, although most students said this was not a reason to work on their clinical skills. Students said they would prefer to receive feedback on other skills besides communication, because as things were now, they felt they were just playacting.
"In our group no feedback is given about content aspects. So I say to someone with an ankle, well let me feel your ankle, come over here. Sit down please and then I do a fake examination which is wrong in every possible way." (year 1, group 2, student 4).

First and second year students thought real patients were too far in the future to be a stimulus to practise right now.
"This year I haven't given any thought to real patients not at any moment [when practising skills] *but maybe next year I will think more about real patients when I am going to a general practice."* (year 2, group 1, student 2).

Third year students have regular patient contacts in hospital and primary care settings. They said these were highly motivating. There were three distinct effects of real patient contacts in the third year with relevance to clinical skills:
1. Real patient contacts stimulate students to practise clinical skills.
2. Real patient contacts cause confusion about 'what is the correct way'.
3. Real patient contacts lessen the 'shock of practice'/make students feel more prepared for the reality of clinical practice.

As for preparation, the third year students described that they practised specific parts of clinical examinations (e.g. special knee tests) focused on the department where they had patient contacts. Most students said they prepared and practised for two reasons: (1) the patient and (2) self-confidence. Students want to come across as being competent and in control during the patient encounter. Where students in earlier years mentioned peer pressure and supervisors' expectations as strong incentives for learning, the third year students remarked that the importance of those factors faded when real patients came into play.
"In the first 2 years it was only for the test, like I have to start cramming to pass the test and now, in third year, with a patient… you do not want to be there not knowing how to do a lung examination." (year 3, group 1, student 6).

"It is not so much for the supervisor, it is more towards the patient." (year 3, group 1, students 4).

"It is simply not acceptable to mess around." (year 3, group 1, student 7).

"It is quite important when you are with a patient that you know what to do and that you are not standing there aimlessly. For me that is the main motivation to prepare really well." (year 3, group 2, student 7).

Influence of clinical environment
Students described several confusing experiences when they first entered the clinical environment. Overall, students found that the reality of clinical practice in Year 3 was rather shocking because it confronted them with deficiencies in their knowledge and skills.
Being confronted with a different culture, an unfamiliar role and novel interaction with healthcare staff also made them feel uncertain. Time pressure and competing interests were frequently mentioned as having an adverse effect on the quality of clinical skill performance. Students reported that it was difficult to choose the most appropriate skills, because they were used to doing a full physical examination.

*"And with physical examination you are taught to listen for so long and at so many places and then you are with a GP and he puts his stethoscope at 4 places within 30 seconds… it is a matter of more experience as well." (*year 3, group 1, students 5).

In addition, students noticed that there was little agreement among clinicians concerning the correct way to perform certain skills. Some students reported negative experiences involving clinicians that openly doubted the validity of techniques that were taught at the university. This caused increased anxiety and confusion. In general, students thought they learned a lot from seeing practising physicians perform. Tips and tricks on efficiency and dexterity were particularly useful for students.
"With the abdomen you have a skills lab and you are taught to determine the outline of the liver and we are taught to do that in such a way that you think…about here, for I know it should be approximately there … but he showed us a way that works really well. You put your stethoscope here and then you brush with your finger and then you hear the difference where you are brushing, you hear it extremely clearly. It seems strange that we should not learn this in the skills lab." (year 3, group 1, students 3).

Differences between years
Students in the final semester of year three reported a subtle shift in how they worked compared to year 1 or 2. They noticed that they had built a progressively more integrated knowledge base, not just incorporating basic and clinical science knowledge but also physical examination skills.
"You know more and more and at a certain point things start to fall into place. Right now I notice this very strongly with skills: you are thinking more and more like I hear this and I hear that and you can make connections […] *and in the first year I just outright memorised lists."* (year 3, group 1, student 4).

"You integrate different steps of the examination. When you have seen something on inspection, you think during auscultation 'hey I just have to hear that' ." (year 3, group 1, student 5).

This shift, from 'how do I do this' to 'why am I doing this and what does it mean', was regarded by the students as a very positive confirmation of their growing competence. Although the prospect of clinical rotations was still quite daunting, many students felt well prepared and confident with regard to their physical examination skills. Students expected their experiences in Year 3 would help to ease the transition to clinical training.

"In the clinic I never really feel that I might be deficient in examination skills, I think that I am more likely to have deficiencies in knowledge to interpret […] *I am quite capable of doing a physical examination."* (year 3, group 2, student 8).

One reported drawback of students' early experiences with the clinical environment is how it affected their preparation for the OSCE. Many students saw the step-by-step approach they were expected to use in the test (''*checklist*'') as an unnatural regression towards the type of thinking they had used in the first 2 years. They argued that they would benefit from a holistic rating procedure that favoured diagnosis-driven thinking over linear thinking (i.e. ticking off each box for every small step).
"I think it is good that you learn the basics and then move on but I think it is a pity that you have to put on an act for the OSCE….'It should be done precisely so' and even if the doctor at the exam does things very differently himself but it is not on the scoring form, it has to be done exactly as it is written. You feel as if you are in a play." (year 3, group 1, student 4).
"When you do an examination you do it because you have an idea at the back of your head and you want to find something in the patient and then you think of a diagnosis and the observer says that you did not look at the pattern of the hair on the legs in relation to circulation deficiencies. You could not see it because the legs were shaven but when you would have said it would have meant an extra mark. It's just so stupid, things like that I just don't need them." (year 3, group 2, students 3).

Influence of the nature of the examination
The students reported a wide variety of study habits with regard to clinical skills.
Two factors in particular appeared to stimulate students to practise:
- Skills that are difficult to perform.
- Skills that are enjoyable to perform.

Students felt they had to do more practice for skills they considered more difficult than others, such as breast examination. One student reported having paid extra attention to this skill because a relative had been recently diagnosed with breast cancer. Other students said they rehearsed this skill (not by actually practising the skill but by reading up on the procedure), because they were expected to examine their peers and felt this examination was more intimate than others.
"I think that unconsciously it plays a role. It is not so much embarrassment but because you feel you have to be able to do it. You do not want to seem backward or something." (year 2, group 1, student 6).

"Because you practise on someone and it is quite stressful the first time." (year 2, group 2, student 6).

A strong motivator among Year 1 students was the enjoyment they felt in performing certain skills. Auscultation of the heart and lungs was frequently mentioned as being enjoyable to do, as was bandaging. We will discuss additional benefits of this approach later.
"What I also do is practising at home on my girlfriend, my father, my mother. Anyone who feels like it comes under the stethoscope." (year 3, group 1, student 2).

Discussion

This study aimed to explore how students work outside scheduled training sessions to improve their physical examination skills, and what factors play a role in this. Using a combination of qualitative and quantitative methods, we discovered that students report a variety of activities to improve their physical examination skills. On average, students devote 20% of self-study time to skill training with Year 1 students practising significantly more than Year 3 students. Learning resources used include textbooks, examination guidelines, scientific articles, the Internet, videos/DVDs and scoring forms from previous OSCEs. Student practise skills on fellow students, family members or friends at university rooms or at home.

The motivation to practise is influenced by both external and internal factors. Assessment provides a strong incentive for students to practise, caused by anxiety about the format of the exam and the expected level of competence. Real and simulated patient encounters also motivate students to practise their skills. Students mention patient pressure and supervisors' expectations as drivers for learning. In later years the impact of those external factors gradually fades and is replaced by intrinsic motivation. Students report that practice increases their self-confidence and perceived level of competence.
In conclusion, students' practice patterns shift from just-in-time learning to a longitudinal self-directed approach during the first three years of the curriculum. Factors influencing this change are A) assessment methods and B) authenticity of the learning environment by introducing simulated/real patients.

These outcomes are in line with other research on the transition from preclinical to clinical training.[16,26,27] However, the current study is the first to address the acquisition of physical examination skills and the strategies students adopt to master these. We

will consider theoretical explanations for the reported findings, and discuss possible implications for medical education.

Influence of assessment methods

The influence of OSCEs on students' practising behaviour provides partial support for the conventional assertion that assessment drives learning.[28,29] However, our results also reveal significant incentives for learning that are not related to assessment. The OSCE does influence learning strategies, but learning takes place also when there is no upcoming assessment, as is demonstrated by the influence of real patients. This shows that students will work on their physical examination skills, even when they do not know if and when they will be formally assessed. Intrinsic motivation to practise for (simulated) patient encounters is high. We therefore propose to modify the maxim 'assessment drives learning' to include 'and patients drive practising' within the context of physical examination skills. The influence of early patient contacts on learning physical examination skills extends the growing body of evidence on patient-based education into the skills domain.[30]

Contrary to earlier studies, which investigated time spent preparing for an OSCE[17,18] we found that the larger part of practice time is dedicated to skill performance rather than reviewing textbooks and notes.

Students in Year 3 practise less outside timetabled training sessions as they (1) feel increasingly competent and (2) have opportunities to practise on real patients in general practice and hospital settings. A recent study also found that students regularly practised skills on each other outside timetabled training sessions.[17] These spontaneous, self-directed group learning activities seemed to be inspired by a PBL-environment. This cooperative/collaborative learning may be seen as a manifestation of the 'hidden curriculum' [31] and as such warrants more research.

Authenticity of the learning environment

The reported shift towards clinically oriented thinking was addressed in earlier studies on knowledge acquisition in the theoretical curriculum.[23,32] Our findings complement the theory that students progressively integrate their knowledge and skills while problem-solving. Cognitive psychological theories of clinical reasoning have emphasised that the structure of knowledge differs in experts (clinicians) and novices (medical students).[33] As expertise develops and medical students acquire extensive clinical experience, they develop the ability to recognize and manage symptoms efficiently and effectively. Our findings suggest that early introduction of skills training contributes to the development of competence and confidence in physical examination skill performance.

Remmen et al. demonstrated earlier that longitudinal skills training is more effective than clerkships to learn physical examination skills.[11]
Early exposure to physical examination skills would therefore assist students in developing an extensive cognitive database of possible clinical findings as preparation for clerkship rotations. During their clerkships this database will develop further. Seeing patients in clinical care will spur the development of 'illness scripts', cognitive structures that clinicians use for storing and organizing information about patient symptoms and conditions in memory.[34] Illness scripts contain not only clinically relevant information about patient cases, but also the context in which the case was seen. In everyday practice, the resulting 'pattern recognition' allows relevant information to be retrieved efficiently thereby contributing to a doctor's ability at differential diagnosis.[35]

In this model, based on cognitive psychological research, the more opportunities students have to see patients or to be exposed to clinical material, the richer their database of illness scripts will be. This will provide more opportunity to organise schemes of relevant information in memory readily available for quick retrieval when needed.[36]
Consequently, including clinical scenarios or (simulated) patients in physical examination skills teaching will assist the development of clinical competence.
Physical examination skills are demonstrably an important part of the diagnostic process.[37] There is evidence that diagnostic accuracy improves with training and time spent on a task.[38] Exposing medical students to a large number of clinical cases improves their performance[39], especially when combined with quality feedback.[40]
Although feedback during performance is important, research in skills acquisition has shown that humans learn best if feedback is incorporated in training designs.[41] Students in our study emphasised the motivational effect that (simulated) patients have on their practising behaviour, but they felt that feedback on their physical examination skills was sometimes lacking. Evidence shows that individual feedback and remedial instruction in general improve learning outcomes.[42] Provision of feedback immediately after summative tests has been associated with improved competence.[43] In addition to the large body of literature on feedback in general, several studies have described feedback during physical examination skills training.[44-47]
The learning effect is boosted when feedback is specific, for example when teachers highlight which aspects of physical examination skills are redundant in reaching a correct diagnosis, or when teachers point out areas where more work is needed. Those examples were deduced from research on preclinical teaching, but evidence suggests that the underlying principles would also be valid in the clinical learning environment.[48]
One of the central themes emerging in our study was the motivational effect (simulated) patients have on students. Next to the resulting drive-to-practise this has on students, additional benefits can be bolstered with literature. The transition to the clinical

phase of undergraduate medical education has often been described as a stressful period.[16] Students experience stress due to increased working hours, uncertainty as to what is expected of them and self-perceived lack of knowledge.[49]
Boshuizen described how the resulting 'shock of practice' is associated with a temporary decrease in students' ability to properly use biomedical knowledge in clinical reasoning.[50] Students in our study described similar confusing experiences during their first patient contacts. However, in contrast to the literature on the 'shock of practice' these first patient contacts took place before the clerkship phase. Our findings suggest that early patient contacts in physical examination skills teaching may improve students' preparedness for clinical clerkships. Recent research adds more evidence to the value of early patient contacts in overcoming the 'shock of practice'.[27,30,51,52]
Learning physical examination skills in a longitudinal integrated skills programme could facilitate a student's ability to perform those skills in the 'real world': the clinical workplace.[11] Our findings suggest that students feel well-prepared to do so and show that students use the skills learned when examining (simulated) patients.

When learning in one situation (the preclinical skills programme) enhances performance in another situation (the clinical workplace), positive transfer has occurred. In contrast, when something learned in one situation (the preclinical skills programme) hinders learning or performance in a second situation (the clinical workplace) then negative transfer has occurred.[53]
Examples of both positive and negative transfer are discussed in our study. Factors contributing to positive transfer are the increasing complexity of skills and using (simulated) patients as authentic stimuli for learning. Conditions adding to negative transfer include socialisation processes, uncertainty about what is expected and conflicting techniques being used in practice.

The implications of our findings for medical education are fourfold.
Firstly, considerations for skills teachers. Our findings show that students in later years are capable of identifying areas that need work, especially when they are confronted with real patients. Students can create learning opportunities to address their shortcomings. Skills teachers could accommodate this process by using a student-centred approach, empowering students to take an active role in their learning.[54]
Secondly, considerations with regard to the learning environment. Educators should note that authentic learning environments stimulate students to learn physical examination skills. Bringing the real world into the classroom (using simulated or real patients) or taking the classroom to the real world (using outpatient departments to practise) can contribute greatly to the learning of skills. Experiential learning should be considered as an educational strategy for physical examination skills.[55]

Thirdly, considerations for course constructors and the curriculum at large. Building on the considerations for the learning environment, the statements from our students emphasised the importance of alignment of training sessions with (simulated) patient encounters. Curriculum alignment includes both the place of skills training in a course and the arrangement of skills training with communication sessions. Course constructors should safeguard the longitudinal integration of physical examination skills training in the curriculum.
Fourthly, considerations for assessment procedures. Examiners should be aware that students tailor their learning to what they are tested on, and adjust assessment accordingly. This strategy, also called 'measurement-driven instruction' can have powerful educational consequences.[56-58]
One such adjustment might be to revise current OSCE models, and abandon the checklist approach in favour of a more clinically oriented test which allows for variation in thinking.[59] Such a test puts different requirements on examiners, and this has implications for staff training.

The limitations of this study are that we relied on students' self-reports and thereby on their perceptions. Another limitation is that the confidence or lack of confidence of the students in their own abilities is not known and this would influence their perception of their learning of clinical skills. It should also be taken into account that the students who accepted the invitation to participate in our study might be the most enthusiastic ones. Even though saturation was reached in all focus groups and all groups discussed similar themes, it cannot be ruled out that NOT all themes were appropriately covered. Nevertheless, we think self-reporting is a strength too, since the impact of various influences on practising behaviour will be mediated through self-perceptions. Another strength is our sequential approach, combining self-reporting by questionnaire and focus groups. The high response rate on the questionnaire and the iterative procedure adopted for the qualitative analysis assure representativeness of our findings. The translation of our findings to other curriculum structures needs further clarification.

This exploratory study has indicated areas for further study: the introduction of early patient contacts, clinical reasoning in undergraduate years and innovative assessment of clinical skills. Further research should also explore if and how self-reported study behaviours are related to performance in clinical situations and achievement on formal assessments.

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CHAPTER 6

The Role of Deliberate Practice in Learning Clinical Skills

Based on:

Duvivier RJ, Dalen J van, Muijtjens AM, Moulaert V, Van der Vleuten CPM, Scherpbier AJJA. The Role of Deliberate Practice in the Acquisition of Clinical Skills. *BMC Medical Education* 2011; 11:101

Abstract

Background

The role of deliberate practice in medical students' development from novice to expert was examined for preclinical skill training.

Methods

Students in years 1-3 completed 34 Likert type items, adapted from a questionnaire about the use of deliberate practice in cognitive learning. Exploratory factor analysis and reliability analysis were used to validate the questionnaire. Analysis of variance examined differences between years and regression analysis the relationship between deliberate practice and skill test results.

Results

875 students participated (90%). Factor analysis yielded four factors: planning, concentration/dedication, repetition/revision, study style/self reflection. Student scores on 'planning' increased over time, score on sub-scale 'repetition/revision' decreased. Student results on the clinical skill test correlated positively with scores on subscales 'planning' and 'concentration/dedication' in years 1 and 3, and with scores on subscale 'repetition/revision' in year 1.

Conclusions

The positive effects on test results suggest that the role of deliberate practice in medical education merits further study. The cross-sectional design is a limitation, the large representative sample a strength of the study. The vanishing effect of repetition/revision may be attributable to inadequate feedback. Deliberate practice advocates sustained practice to address weaknesses, identified by (self-)assessment and stimulated by feedback. Further studies should use a longitudinal prospective design and extend the scope to expertise development during residency and beyond.

Introduction

The ultimate goal of medical education is to prepare students to become clinically competent doctors. During their years in medical school and the hospital undergraduate students begin the gradual transition from novice to expert, a process that is by no means an easy one.[1-3] Research in other domains has shown that it requires hard work to become very good in a particular area of expertise. Chase and Simon, for example, argued that it takes ten years of intensive practice to reach expert level in a particular field.[4]

Ericsson made a distinction between work, play and training.[5] Work entails activities that primarily lead to immediate monetary and/or social rewards. Play involves activities that have no explicit goal and are inherently enjoyable. For training Ericsson introduced the concept of 'deliberate practice', characterising training as a highly structured activity explicitly directed at improvement of performance in a particular domain.[6] Specific tasks are invented to overcome weaknesses and performance is carefully monitored to provide cues for ways to achieve further improvement. Deliberate practice is not mere mindless repetition of a certain task, but a focused approach to training aimed at reaching a well-defined goal. Practical implementation of the theoretical construct is based on several design principles[7]:

(a) repetitive performance of intended cognitive or psychomotor skills
(b) rigorous skills assessment
(c) specific informative feedback
(d) better skills performance

Research has shown that training activities guided by these principles help the acquisition and maintenance of expert performance in sports and music[8], but also in typing[9], economics[10] and chess.[11] Ericsson discussed the use of deliberate practice in medicine, but his theoretical examples were limited to clinical performance of qualified doctors.[12,13]

Exactly how the use of the principles of deliberate practice can contribute to the development from novice to expert during undergraduate medical training and beyond remains unclear, although there is evidence that deliberate practice leads to effective performance with high-fidelity medical simulators.[14,15]

Moulaert et al. explored whether the theoretical principles of Ericsson could be identified in the study habits of undergraduate medical students.[16] Aspects of deliberate practice were positively correlated with results on knowledge and skills tests.

Moulaert's paper addressed study habits of students in the cognitive component of the curriculum. Although recent developments in undergraduate medical curricula have

also emphasised the acquisition of clinical skills, little is known about students' learning strategies with regard to these skills. Physical examination skills are predominantly psychomotor by nature. Since research in other domains has shown that the principles of Ericsson's theory are applicable to training in psychomotor skills such as tennis and golf[17], it seems worthwhile to investigate whether deliberate practice can be of benefit in the area of clinical skills learning too.

Based on Ericsson's theory of deliberate practice and the available evidence of its effectiveness in other domains, we hypothesised that training activities grounded in deliberate practice can be effective in undergraduate clinical skill training.
We further hypothesised that more senior students exhibit more aspects of deliberate practice, due to effective learning habits acquired as they progressed through the curriculum. Based on these hypotheses, we assumed that engaging in deliberate practice would positively affect students' performance in clinical skills. We have operationalized this by comparing scores on formal assessments of clinical skills.
We addressed the following research questions to examine our hypotheses:

1) Which aspects of deliberate practice can be identified in the behaviour of medical students when practising clinical skills?
2) What development can be seen in the use of deliberate practice across different years of study?
3) To what extent does deliberate practice have predictive value for results on Objective Structured Clinical Examinations (OSCE), and which aspects contribute the most?

In order to answer these questions we conducted a quantitative cross-sectional retrospective study, using a questionnaire to investigate students' engagement in different aspects of deliberate practice.

Methods

Setting

The study was carried out at the Faculty of Health, Medicine and Life Sciences, Maastricht University, the Netherlands in 2008. Skill training receives a great deal of attention throughout the six-year medical curriculum. In the first three years the curriculum is organised in thematic blocks of six to ten weeks each focused on a specific group of patient problems or conditions. The main educational format is problem-based small group sessions, with additional lectures, skill training and laboratory sessions. The sub-

jects of skill training are aligned with the themes of the problem-based sessions. Years 4-6 consist of clinical placements, and skill training in these years focuses on revision and remediation. All skill training takes place at the Skills Lab, a specialised educational facility. A skills training session for undergraduates (year 1–3) consists of a four-stage process involving tutor demonstration, followed by explanation, practice under supervision with feedback and corrective critique. Most sessions start with a discussion of students' preparatory reading. Next, the teacher demonstrates the skill using a student, a (simulated) patient or a model, after which students practise on models or one another. Finally, the teacher summarises the session and students can ask questions.[18]

Students take a skills test at the end of years 1, 2, 3 and 5. This is a performance-based test consisting of multiple stations where students are presented with different clinical scenarios (OSCE). Each student undertakes the same series of tasks, and performance is graded by trained physicians using station-specific standardised checklists. Each checklist contains key items that the student must perform to gain a satisfactory rating. The overall OSCE result is based on the total number of correctly performed key checklist items.

Questionnaire

Moulaert's questionnaire was based on the literature on expertise development and reviewed by eight medical students and eight experts in cognitive psychology and educational science. We adapted this questionnaire to fit skills training, and justified the content validity to guarantee transferability to this domain. It was piloted among four medical students, reviewed by four medical education experts and modified in response to their comments. The final questionnaire took approximately ten minutes to complete and consisted of 34 items requiring a response on a five-point Likert scale (1=never, 5=always). Students received oral and written information about the purpose of the questionnaire. All students gave informed consent.

Our aim was to include all undergraduate students in the first three years. Immediately after they attended the skill test of curriculum year 2008-2009, all students in years 1-3 were requested to complete the questionnaire. Skills tests are scheduled at the end of the academic year. Participation was voluntary and students received no financial reward for participation. Students received their individual test result 6 weeks after completion of the test, as is standard procedure at Maastricht University. For each participating student we linked OSCE results and questionnaire data. In order to guarantee anonymity, an independent data analyst changed all student ID numbers into random numbers.

Data analysis

All analyses were performed using SPSS Software (version 15.0 for MS Windows). A p-value of 0.05 was the threshold value for significance.

Research Question 1
We performed exploratory factor analysis and reliability analysis to validate the adapted questionnaire. Extracted factors constituted subscales of aspects of deliberate practice.

Research Question 2
In order to answer the second research question, we conducted analysis of variance (ANOVA) to investigate between-year differences in aspects of deliberate practice. After calculating mean item scores for each factor we used Bonferroni correction to safeguard against type I errors.
We calculated effect sizes (ES) for all comparisons expressed as Cohen's *d*. Hojat and Xi define the practical importance of effects sizes as ES ≈ .20: small effect size of negligible practical importance; ES ≈ .50: medium effect size of moderate practical importance; and ES ≈ .80: large effect size of crucial practical importance.[19]

Research Question 3
In order to answer the third research question we used regression analysis to investigate which aspects of deliberate practice were associated with OSCE results.
We calculated mean z-scores for the OSCE results in each of the three years.

We calculated the mean scores for the subscales resulting from the factor analysis and used regression analysis to estimate the correlation with OSCE scores. OSCE scores were available for 93% of the students. We were not able to retrieve OSCE results for all students due to several reasons; wrong or invalid student ID used on the questionnaire, duplicate student ID used, withdrawn OSCE results. To prevent possible confounding by age and gender these variables were included in the regression analysis as additional independent variables.

Results

Descriptive statistics

We aimed to include all students in Years 1, 2 and 3, but were unable to reach some of them. Of the total of 972 students invited to participate, 875 completed the questionnaire giving an overall response rate of 90%. Respondents were distributed evenly over the three years, with 298 (92%), 292 (87%) and 285 (90%) students in Years 1, 2 and 3, respectively. Twenty-four students did not state their year of training and eight students did not fill in their student ID.

The mean age of the respondents was 20.1 years (SD=1.24 years) and female students accounted for 68%. This is in concordance with the overall age and gender distribution in the student population of Maastricht medical school.

Research Question 1: Aspects of deliberate practice

We verified whether the consistency of the data justified the use of factor analysis. As the Kaiser-Meyer-Olkin measure of sampling adequacy (MSA) showed that partial correlations among variables were likely to be large (MSA=.86) and Bartlett's test of sphericity was significant ($p<0.001$) indicating strong relationships among the variables, we concluded that it was appropriate to perform factor analysis. We conducted factor analysis based on principal component analysis and oblique rotation. We used three indicators to determine the number of factors: Cattell's scree plot, eigenvalues and whether the resulting item clusters represented theoretically meaningful aspects of deliberate practice. Table 1 shows the items in order of descending loadings. The factor analysis yielded four factors:

1. planning (higher scores indicate a stronger tendency to organise work in a structured way);
2. concentration/dedication (higher scores indicate a shorter attention span);
3. repetition/revision (higher scores indicate a stronger tendency to practise);
4. study style/self reflection (higher scores indicate a stronger tendency to self-regulate learning).

Cronbach's alpha was calculated to investigate the internal consistency of the scales (table 1).

Table 1. Items of the factors resulting from the factor analysis.

	Cronbach's Alpha	Mean Score (SD)	Loadings
Planning	**.76**	**3.07 (0.73)**	
When I have a schedule I stick to it.			.801
I am good at planning my time.			.754
I draw up a study schedule.			.672
My study efforts are distributed evenly over the academic year.			.617
I summarise the material I am studying.			.506
On days when there are no obligatory study activities I study mostly in the morning.			.451
I make an outline of the material to be studied.			.389
Concentration/dedication	**.57**	**2.89 (0.71)**	
I stop studying as soon as I get tired.			.704
I usually study in a number of short sessions.			.703
I take breaks when I am studying.			.700
When I am studying I am not easily distracted.			.415
Repetition/revision	**.67**	**2.79 (0.70)**	
I revise skills during unsupervised practice sessions.			.730
I revise skills by practising on other students/housemates/family.			.562
I prepare for skill training sessions.			.479
When I don't understand something I look it up in the literature after training.			.353
I revise material I find difficult			.272
Study style/self reflection	**.73**	**3.61 (0.45)**	
I try to see how different parts of a subject are interconnected.			.732
After studying a subject I am able to explain it clearly.			.635
I pay extra attention to subjects I do not understand.			.666
When something goes wrong in my studies I try to find out what caused it.			.484
I know my strengths and weaknesses with regard to studying.			.408
When I don't understand things during training I ask questions.			.486
I hate it when there is something I don't understand.			.505
I work to improve my weaknesses.			.367
I use different resources to study the learning objectives.			.484
I also read medical articles not directly related to the current topic.			.475

Research Question 2: Comparison between students in different years

The data analysis revealed statistically significant differences between the years for two subscales: planning and repetition/revision (table 2). Scores on the planning scale show an increase in planning behaviour and organisation of work over the years. The differences were of small to medium practical importance (Cohen's d).

Table 2. Comparisons between scores on the subscales in different years.

Factor	**Years compared**	**Difference**	**Effect size (Cohen's *d*)**
Planning			
	Year 2 vs. Year 1	+0.19*	.26
	Year 3 vs. Year 2	+0.05	.07
	Year 3 vs. Year 1	+0.24*	.33
Concentration/dedication			
	Year 2 vs. Year 1	-0.08	.11
	Year 3 vs. Year 2	-0.06	.09
	Year 3 vs. Year 1	-0.15	.21
Repetition/revision			
	Year 2 vs. Year 1	-0.14	.19
	Year 3 vs. Year 2	-0.17*	.25
	Year 3 vs. Year 1	-0.30*	.44
Study style/self reflection			
	Year 2 vs. Year 1	+0.03	.06
	Year 3 vs. Year 2	+0.01	.02
	Year 3 vs. Year 1	+0.04	.09

* significance level 0.05 (2-tailed)

Research Question 3: Relationships between aspects of deliberate practice and test results

Significant positive correlations of factor scores with test results were found for planning in Years 1 and 3 with small to medium effect sizes (table 3). Concentration/dedication scores decreased over the years indicating increased attention span. They showed a significant negative correlation with test results in Year 3 with a small to medium effect. Scores on repetition/revision were significantly positively correlated with test results in Year 1, with a medium effect.

Table 3. Relation between factors and test results.

(Standard Regression Coefficient (Beta))

	Year 1	Year 2	Year 3
Planning	.22*	.13	.16*
Concentration/dedication	-.11	.03	-.15*
Repetition/revision	.22*	.07	-.08
Study style/self reflection	-.07	.03	-.03

* significance level 0.05 (2-tailed)

Discussion

We explored the use of deliberate practice by medical students in learning clinical skills by identifying study habits related to deliberate practice, whether their use changed across different years of study and whether it had a positive effect on students' scores on formal assessments of clinical skills.

The use of deliberate practice in relation to clinical skills in the first three years of undergraduate medical education showed an increase in several aspects. More specifically, students showed progressively more planning behaviour and an increased tendency to structure their work. Furthermore, we found a positive relationship between OSCE performance and some aspects of deliberate practice: repetition/revision in Year 1, planning in Years 1 and 3 and attention span in Year 3.

Our results reveal a trend of increasing use of deliberate practice as students' progress through the curriculum. Students seem to acquire the ability to structure their study

and practice activities, a finding that may be attributable to an increased focus on and awareness of desired study outcomes. Combined with increased concentration/dedication with respect to practising, this increased awareness of desired outcomes may contribute to the effectiveness of practice activities. Thus planning and focusing of attention seem to be aspects of deliberate practice that help students to gradually refine their performance.

Interpreting these combined results, it appears that students gradually learn how to make more efficient use of their time, energy and resources. In short, they seem to learn how to learn.

Research in other domains, mostly by Ericsson and colleagues, has shown that the main determinant of success in expert performers is not the amount of time spent practising, but the amount of time devoted to activities specifically targeted at aspects of performance that need improvement.[20]
After initial mastery of basic skills, some types of practice, the proficient execution of routine tasks for example, are unlikely to lead to further improvement. In other words, repetition in itself is not enough. Progress depends on sustained efforts to purposefully enhance particular aspects of performance. This principle might explain why the positive association we found between repetition and test results was not sustained after Year 1. First year students who are just beginning to learn skills are likely to benefit from any practice effort, regardless of structure and organisation, whereas it seems plausible that a lack of focus on identified weaknesses would hamper learning after Year 1. This would suggest that efforts in Year 3 have to be focused and well planned in order to be effective.

As stated in the introduction, a key challenge for students is to acquire appropriate study habits to support their continuing improvement. While we found aspects of deliberate practice that promoted skill performance, the use of feedback has not been discussed so far. Although it did not emerge in this study as one of the important aspects of deliberate practice, it is crucial to the development of effective learning habits and therefore merits attention. Most of the study habits we have described so far are intrinsically self-directed and depend entirely on students' ability to shape their own learning. Feedback is a prerequisite for all identified aspects of deliberate practice and plays a facilitative role in the development of students' practice habits. It has been pointed out, however, that students are not always capable of recognising areas where further practising is needed[21,22], and may require guidance in identifying the next steps to be mastered. Ericsson has argued that coaches, trainers and teachers (whether in

sport, music or academia) will always play an essential role in guiding the selection, sequencing and form of practice activities.

This brings us to the practical implications of this study. The tentative conclusion seems justified that educators can facilitate clinical skill development by equipping students with skills to use (aspects of) deliberate practice. Thus the teaching of clinical skills should incorporate the use of efficient strategies to practise them.[23,24]
This type of learning is only possible with students' full cooperation. In other words, it requires students' active participation in their learning. Students need to adopt attitudes and strategies that are conducive to the planning of their learning and evaluation of their current and desired skill performance so as to enhance their habits of skill practice. This implies that course designers should accommodate this process by aiming for a learning environment that incorporates these characteristics.
The exact role of the teacher in feedback, and the preferred timing and method of feedback delivery remain to be determined. This is especially important in the clinical years when training moves to the clinical workplace where students are expected to be increasingly able to personally initiate and direct their efforts to acquire knowledge and skills rather than rely on teachers. The use of self-regulated/self-directed learning strategies is an important area for further research. The focus of this research might be on clarifying learning in individuals further along the novice-expert continuum, such as residents or senior physicians.[25]

It must be noted here that the concept of deliberate practice (and to a lesser extent self-directed learning) relies on the assumption that learners are able to identify weaknesses in their own performance and knowledge and take measures to address these. These skills need to be acquired through observation and feedback, which can gradually be replaced by self-assessment. Initially, this can be seen to by frequent and adequate assessment. However, for students to become lifelong learners, they need to develop self-assessment skills along the way during their training. The literature on self-assessment has pointed out that medical students, residents and physicians have limited ability to accurately judge their own performance.[26-28]
A recent study confirmed the importance of self-assessment for achieving competent performance. Mavis et al. showed that second-year students who were capable of realistic self-appraisal and had high self-efficacy were more likely to perform above average on OSCEs compared to low self-rated students.[29] Further research on optimal planning of the transition from teacher-assessment to self-assessment is recommended.

The cross-sectional design is a limitation of our study. Although the results afford information about groups of students at different stages in the curriculum, it gives no insight into the progress of individual students. The latter would require a longitudinal design. It should also be noted that the correlations we found do not warrant conclusions regarding causal relationships. In other words the findings provide some insights and signal trends, but these require further investigation using an experimental research design.

The strength of our study lies in the large and representative study sample. Our results could be strengthened by extending the scope of further studies to residents in different specialties and practising doctors to capture the next stages of the continuum from novice to expert. Further studies should also investigate whether deliberate practice remains an important factor in improving performance throughout a professional's career. If so, we should teach students to use this approach from an early phase in their education to maximise its beneficial effects. Finally, it would be interesting to examine whether the concept of deliberate practice in medicine can advance our understanding of expertise development in this domain.

Conclusions

This study investigated the role of deliberate practice in medical students' development from novice to expert for preclinical skill training. We used a questionnaire based on previous research, which was completed by 875 students in years 1-3 (90% of total student population). We examined differences between years and the relationship between deliberate practice and skill test results.

Factor analysis yielded four factors from the questionnaire: planning, concentration/dedication, repetition/revision, study style/self reflection. Student scores on 'planning' increased over time, score on sub-scale 'repetition/revision' decreased. Student results on the clinical skill test correlated positively with scores on subscales 'planning' and 'concentration/dedication' in years 1 and 3, and with scores on subscale 'repetition/revision' in year 1.

The positive effects of deliberate practice (as measured in our questionnaire) on test results merit further study to clarify the usefulness of deliberate practice in clinical skills training, not only in undergraduate students but also in clinical years and during residency.

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CHAPTER 7

Learning Clinical Skills in Workplaces: Literature Review

Based on:

Duvivier RJ, Dalen J van, Boshuizen E, Isba R, Mann K, Spencer J, Tan N, Timmins E, Van der Vleuten CPM, Scherpbier AJJA, Dornan T. Learning clinical skills from real patients in workplaces: literature review. *Submitted.*

Abstract

Objectives To examine evidence about students' learning of clinical skills in workplaces and factors affecting it, and identify strengths and limitations of the available evidence.

Design A realist synthesis of outcomes reported in 2000-2012, by systematic review of bibliographical databases using the keywords physical exam(ination), clinical exam(ination), and skills. Manual hand-search of journals and "snowballing" on the reference lists of relevant articles.

Data sources Bibliographical databases (Medline, Embase, CINAHL, BEI and ERIC) and eight journals (Medical Education, Academic Medicine, Medical Teacher, Advances in Health Sciences Education, BMC Medical Education, Teaching and Learning in Medicine, British Medical Journal, and Journal of the American Medical Association) were searched for publications on the topic, reviewed under the auspices of the Best Evidence Medical Education (BEME) collaboration.

Selection of studies All empirical studies (verifiable, observational data) were included, whatever their design, method, or language of publication. Results were included by consensus on rating of strength.

Results 1) Clinical skills education in workplaces was improved upon by supplementing it with more intensive education or substituting education in a training setting for workplace education. 2) Settings and instructors were interchangeable; outpatient settings could take the place of inpatient ones, community sites were interchangeable with one another and with skills laboratory education, and instructors were interchangeable too.

Conclusion Curriculum developers could optimise clinical education by augmenting experiential learning with skills instruction. A 'continuum model', providing clinical education in both skills lab and workplace settings seems optimal. This review identified a need for more research, especially on the role of teachers and feedback, and the level and nature of support provided to students in workplaces.

Introduction

History taking and physical examination skills are essential for every doctor in every domain of health care.[1,2] Carefully conducted physical examinations improve the timeliness of diagnosis and hence the quality of care.[3] Medical histories and physical examinations lead to a correct final diagnosis in about 75% of cases.[4]
Clinicians have, however, expressed concern about the quality of students' and residents' clinical skills.[5-9] As a result, many medical schools now have `clinical skills centres´ or ´skills labs´[10,11], in which instructors follow standardised instructional guidelines in order to achieve predetermined learning outcomes.[12] Regulatory bodies such as the UK General Medical Council[14] have driven this move towards competency-based education[13], which makes it easier to monitor students' progress and test their clinical proficiency.[15]

Without denying its value, there is a danger that simulation becomes an alternative rather than an adjunct to clinical practice. The so-called 'retreat into the simulacrum'[16] has not been uncontested and it is particularly striking that the rise of simulation in the clinical phase of medical curricula has coincided with increased provision of real patient learning in preclinical curricula.[17-19] It seems important, then, to re-examine the contribution authentic experience can make to clinical education. We set out to examine evidence about students' learning of clinical skills in workplaces and factors affecting it.

Methods

The search for relevant publications had two stages. First, relevant papers were identified from an earlier review of medical students' learning in workplaces. Described in full elsewhere[20] the review had applied a sensitive search strategy to Medline, Embase, CINAHL, BEI and ERIC and identified 167 empirical publications about how medical students learn from real patients among 74,000 'hits' covering the period 2000-2006. Just four of the 167 publications described how students learned clinical skills from real patients. Having found so little relevant evidence, we decided to hand-search journals in which quality evidence – if any were available – would most likely be found. Therefore we searched publications that appeared between the years 2007-2012 in the journals Medical Education, Academic Medicine, Medical Teacher, Advances in Health Sciences Education, BMC Medical Education, Teaching and Learning in Medicine, British Medical Journal, and Journal of the American Medical Association using the keywords (or parts thereof): physical exam(ination), clinical exam(ination), and skills. Papers were

elected if they scored 3 or higher on the BEME 1-5 strength scale (See box 1), as recommended in a recent publication.[21]

Box 1. BEME rating scale for strength of evidence.

1. No clear conclusions can be drawn; not strong
2. Results ambiguous; there seems to be a trend
3. Conclusions can probably be based on the results
4. Results are clear and very likely to be true
5. Results are unequivocal

Two authors (RD and TD) reviewed the abstracts of all 1403 hits and retrieved full text copies of any relevant articles. We identified four additional papers. Next, we used a snowballing technique to search for additional articles in those papers but no new ones were found. The final dataset reported here, therefore, consists of eight papers that were deemed both relevant and informative. See table 1 for characteristics of included studies. Because the evidence was heterogeneous i.e. some was qualitative and some was quantitative, we tabulated the evidence about the outcomes of clinical education and the process and conditions that led to them as shown in table 2. The research team validated the data analysis against the original eight full-text papers.

Table 1. Characteristics of included studies

Name	Year	Country	Study design	BEME strength of evidence rating	Cook's classification
Ault	2002	USA	Comparative; randomised parallel	4	Justification research on educational interventions
Fox	2001	UK	Comparative; non-randomized sequential	3	Justification research on educational interventions
Ogur	2007	USA	Comparative; non-randomized parallel	3	Justification research on educational interventions /description of new programme
Pfeiffer	2010	USA	Comparative; non-randomized parallel	4	Justification research on educational interventions
Raj	2006	UK	Comparative: randomized parallel	4	Justification research on educational interventions
Smith	2008	USA	Comparative; randomized parallel	4	Justification research on educational interventions
Teichman	2001	USA	Non-comparative	3	Description without assessment
Widyandana	2011	Indonesia	Comparative; randomized parallel	3	Justification research on educational interventions

Table 2. Conditions and outcomes of included studies

Name	Type of Setting	Type of learning	Real patient learning	Main Conclusion	Main outcome measure
Ault	Surgery rotation; 3rd year students	Three-part skills workshop (reviewing actual screening mammograms, standardized patient station, practice with latex breast models) vs. 4-hour participation in outpatient breast clinic	Participation in outpatient clinic	Ambulatory experience was less effective in learning breast examination than intensive non-authentic breast examination training	Better breast examination skills on models in OSCE
Fox	Rheumatology rotation, final year students	Rheumatology rotation: structured neurology teaching (10h) vs. control group (no additional training)		Combining intensive skills instruction in peripheral nervous examination with Year 3 clerkship leads to better performance compared to control group	Increased scores on station in neurology at end-of-year OSCE
Ogur	Longitudinal integrated clerkship;	Year-long ambulatory clinics in an integrated clerkship		Students participating in novel intensive integrated clerkship had higher scores on OSCE and comprehensive clinical skills self-assessment compared to control group	higher scores on OSCE and comprehensive clinical skills self-assessment
Pfeiffer	Continuity clerkships in paediatrics, medicine, family medicine	half day/week 3-year continuity preceptorships at one site specialty	Forming mentoring relationship with generalist physician, shadowing outpatient clinic, experience continuity in patient care, seeing patient independently	Performance of clinical skills in SP OSCEs was not affected by primary care specialty of students' clerkship	Clinical skills performance on SPs in OSCE

Name	Type of Setting	Type of learning	Real patient learning	Main Conclusion	Main outcome measure
Smith	Medicine rotation; 3rd year students	Medicine rotation 11 week inpatient clerkship; weekly bedside instruction (12h total) vs. control group (no additional training)	Examining patients with "abnormal physical findings"	Intensive physical diagnosis bedside teaching in addition to regular clerkship activities enhances clinical skills	Better performance of clinical skills on real patient OSCE when compared to control group
Teichman	Urology rotation; 3rd year students	Outpatient clinic during urology rotation		Students learn to perform physical urogenital examination from seeing patients	Perceived better urology clinical examination skills on survey
Widyandana	Primary care placement, 4th year students	attachment in primary health centre vs. regular skills training in skills lab	Seeing real patients under supervision of GPs	training in skills laboratory combined with PHC attachments leads to higher level of perceived preparedness but has no influence on student performance on OSCE as compared to regular training in skills lab alone	Clinical skills performance on OSCE

Results

Five of the eight papers came from the USA, two from the UK, and one from Indonesia. Two papers reported on studies in community/primary health care sites; all others were conducted in hospitals. Most studies tested whether one educational intervention was better than (or as good as) another. This is what Cook et al termed 'justification' research.[22] Study methodologies differed but most used comparative designs, either randomized or non-randomized, with post-intervention assessments to measure impact. Objective Structured Clinical Examinations (OSCEs), either as part of routine

summative assessment or implemented specifically for research purposes, were most commonly used to evaluate skills.

All eight studies showed how learning could be enhanced and/or flexibility could be introduced to curriculum design: three studies showed that students' ability to demonstrate physical examination skills could be improved by skills instruction on top of normal clinical activities. Four showed that instruction in one setting could be usefully replaced or improved upon by experience in another setting. And one paper showed the comparability of professional and lay instructors.

Four studies found that learning could be improved by augmenting or changing methods of instruction: intensive, structured training in peripheral nervous system examination provided as an adjunct to a rheumatology rotation improved neurological examination[23]; weekly structured bedside instruction improved clinical competence during a clinical rotation[24]; an intensive integrated clerkship improved competence over a rotation-based programme[25]; and intensive, breast examination training in a non-workplace setting improved competence over real patient learning in ambulatory settings.[26]

Four studies found that instructional settings and instructors were interchangeable: Students found out-patient clinics better environments for learning urogenital examination skills than in-patient settings[27]; a combined clerkship programme, where students traded part of their formal instruction time in a skills laboratory for supervised attachments in primary health care, achieved equivalent competence[28]; different types (site and specialty) of community continuity preceptorship achieved equivalent clinical competence[29]; and hand and knee examination could equally well be learned from specialists and trained patient educators.[30]

Discussion

Principal findings and meaning

This study had two main findings: 1) Clinical skills education in workplaces was improved upon by supplementing it with more intensive education or substituting education in a training setting for workplace education. 2) Settings and instructors were interchangeable; outpatient settings could take the place of inpatient ones, community sites were interchangeable with one another and with skills laboratory education, and instructors were interchangeable too. Curriculum developers, these findings suggest,

could optimise clinical education by augmenting experiential learning with skills instruction.

Strength and limitations

A strength of this review is that it combined a highly sensitive search with a focused search for recent evidence. Furthermore, we increased sensitivity for informative papers by a 'snowballing' technique. Our process of selecting articles from the ones we identified can be seen as a strength or a limitation depending on the epistemological stance from which it is viewed. From the positivist perspective of traditional systematic review, our inclusion criteria were lenient and resulted in weak evidence being included. Systematic reviewers of education evidence have, however, been exhorted to move forwards from lamenting a lack of "strong" education evidence to accepting that education's essential situatedness in practice calls for different types of evidence.[31,32] From that perspective, the validity of randomized trials is threatened by the necessarily 'artificial' conditions in which they are conducted[31,33] and other types of intervention can provide valid evidence. Our analysis of links between the outcomes of education, the processes that led to them, and the conditions in which studies were conducted has a realist epistemological orientation.[34] From that perspective, our data support one simple, firm conclusion: wherever researchers have looked, they have been able to find different, and sometimes better, ways of delivering clinical skills education. Simulation and experiential learning, in particular, can supplement one another.

Implications for practice

Our findings argue for a 'continuum model', providing clinical education in both skills lab and workplace settings. Novices, then, could learn the basics of new skills in skills labs, refine them with actual patients in clinical workplaces, and then 'transfer' them to authentic practice. Available evidence has been insufficient to answer the question: just how intensely and when do we need to support clinical skills learning in workplaces? All the studies reported in this review were with 'clinical' students (Years 3-4 US, Years 3-5 UK) but little detail was provided about clinical and skills lab experience in the early curriculum years, leaving it unclear what kind of preparation is needed for students to engage in real patient learning. The need for a continuum model is supported by the finding that skills performance during clerkships can usefully be augmented with non-authentic training on mannequins. Training, then, can be calibrated to the needs of individual learners and integrated with their real patient experiences.

Implications for research

This review has exposed the need for more research into the process of learning clinical skills from real patients exploring, for example, the optimum length of contact between teachers and learners and how the best opportunities for practice and feedback can be provided. How can students best be supported to learn these skills in workplaces? What is the role of preceptors? Longitudinal research following cohorts of students as they develop into medical specialists could identify factors stimulating and impeding the learning of clinical skills. Moreover, the role of skills labs in helping students engage with real patients needs further clarification. Do skills labs allow for the breakdown of tasks into their component parts to aid learning?

Providing clinical skills education within an increasingly complex health care system continues to be challenging. Both skills instruction outside workplaces and experiential learning within them have complementary parts to play.

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CHAPTER 8

Influence of the Hospital Workplace on Learning Clinical Skills

Based on:
Duvivier RJ, Stalmeijer RE, Dalen J van, Van der Vleuten CPM, Scherpbier AJJA. Influence of the Hospital Workplace on Learning Clinical Skills. *Submitted.*

Introduction

A large part of medical education is situated in the workplace. This educational environment is however entirely different from the environment found during the pre-clinical years in medical school.[1-3] And although clerkships are considered crucial for acquiring a range of competencies, such as diagnostic reasoning and physical examination skills, the actual learning process in the clinical learning environment remains poorly understood.[4] Merely placing students in a clinical setting does not automatically lead to learning[5], and offering learning opportunities does not mean that students automatically make the most of them.[6] Several attempts have been made to understand learning processes in clinical practice but the actual components that constitute the learning experience remain underexposed.[7-9]

The transition from the pre-clinical years to the clinical workplace is known to be a difficult period for students.[10] The sharp contrast experienced during this period has been named 'shock of practice'.[11] One of the problems reported by students is difficulty in applying previously acquired knowledge and skills to real patient problems.[12,13] However, the level of student's prior knowledge and skills seems to have limited influence on performance during the transition period. On the longer term, the perceived difficulty of the transition period in their first clerkship has no negative effect on student progress.[14] After the initial period of 'shock of practice' students are able to use their knowledge and skills in real-life patient situations.[15]

Researchers' attention has mostly been focused on the contribution of clerkships to students' knowledge[16] or their professional attitude[17,18] and socialisation into the profession.[19] Little is known however about the value of clinical placements in the training of physical examination skills. Observations made in the past decades gave rise to concerns about the effectiveness of clerkships for developing physical examination skills.[20] Undergraduate clinical training was perceived as inadequate in terms of consistency of skills taught to medical students and competencies achieved.[21] There was also evidence of a mismatch between skills taught and those necessarily required for practice.[22] Furthermore, students expressed dissatisfaction with their training.[23]

Over the past twenty years, several studies have confirmed the inadequacy of clerkships to learn skills. Remmen for example showed that students following a curriculum with an elaborate skills training programme in the pre-clinical phase practised significantly more basic clinical skills during clerkships.[24] Further studies showed that student performance of physical examination skills was unsatisfactory in curricula which relied on clerkships as the main teaching methods for those skills.[25] Longitudinal skills labora-

tory training and assessment in the preclinical years act as facilitators for skills training during clerkships later in the curriculum.[26]
Furthermore, at individual student level learning experiences in clerkships differ substantially due to variations in patient mix, supervision and student numbers.[27] Studies of didactic processes during clerkships show that teaching of physical examination skills is often substandard.[26,28-30]

In light of these findings and the lack of understanding how skills are acquired during the clinical phase of medical education we aimed to provide more insight into the process of learning physical examination skills in a work-based setting. We therefore pose the following research questions, to be addressed through qualitative methodology;
- How do students describe the process of learning clinical skills in the workplace?
- Which factors influence this process of learning?

Methods

Context of the study

This study was carried out at the Faculty of Health, Medicine and Life Sciences at Maastricht University, the Netherlands. The six-year medical curriculum consists of problem-based learning in the 3-year pre-clinical phase, followed by two years of clinical rotations in various departments. The final year consists of an 18-week research internship and an 18-week clinical internship in a single department.

Clinical skill training in the pre-clinical years is delivered in parallel with the six to ten-week block content. The skills training programme is developed, organised and delivered by the Skills Lab, a specialised educational facility. A training session typically lasts ninety minutes and is conducted in groups of eight to ten students. Students can prepare by studying recommended reading before training sessions. A typical training session consists of a four-stage process comprising demonstration of the skill by the teacher, explanation of the skill by the teacher, supervised practice (first on models/manikins, then on peers) and corrective critique.[31] During the clinical rotations students receive skills training that intend to refresh and rehearse the essential clinical skills that have been addressed in the previous years. At the end of year 3 there is a compulsory Objective Structured Clinical Examination (OSCE). Performance is scored on checklists by trained observers. Passing the OSCE is prerequisite for advancing to the next stage of the curriculum.

Study design

We chose a qualitative approach of using focus groups to answer our research questions, as it allows for in-depth exploration of students' experiences and it can include a wide variety of perspectives. We chose focus group discussions over individual interviews because we expected the interactions and group dynamics to provide richer data.[32] We organized the sessions according to the guideline described by Morgan.[33] We used an interview scheme based on review of the literature. The interview guide was subsequently discussed within the research team and revised accordingly. It contained general open questions and prompting cues to be asked when elaboration of a topic did not occur spontaneously.

Participants

We chose to use the internal medicine rotation as the focus of our study, because it covers medicine at its broadest. We expected that students would encounter a wide variety of patient problems, physical examination skills and clinical settings. No other hospital-based rotation delivers as much diversity as Internal Medicine. As we did not want to interview students while they were still in the 'shock of practice'; we deliberately invited students who started their rotations at least 6 months prior to the focus group sessions.

We purposively sampled our study participants by inviting students who completed their rotation in internal medicine. As the rotations in Maastricht University are in random order, every month a new batch of students enrols in the internal medicine rotation. We approached these students by email to participate later. All students received information about the study by RJD through a presentation held at the final day of their rotation. All interviewees received written information about the goals of the study and the expected procedures. All participants signed a consent form. We provided lunch during the focus groups and students received remuneration for participation (25 euros).

In total, 32 students who had recently finished their internal medicine rotation participated in six focus group sessions (number of students per focus group ranged 4-9). At that point they had completed a median of 3 rotations. Of the participants 70% was female and 30% was male which is comparable to the overall male: female ratio at Maastricht University. The median age of our interviewees (22 years old) corresponds with the expected age of fifth-year medical students in the Netherlands. The test results of students participating in this study did not significantly differ from the averages scores in their cohort.

Focus Group Discussions

All focus groups discussions were facilitated by one researcher (RES). A second researcher (RJD) observed and took research notes, interrupting to ask additional questions if necessary. In total, we held six focus group sessions between February and May 2011. Each session was 80-90 minutes in length.

Analysis

We started the analysis concurrently with data collection to ensure the elicited responses were in accordance with the research questions. Two researchers (RJD and RES) debriefed after each focus group and discussed the principle themes that were mentioned in that particular session and contrasted these with previous sessions. This iterative process allowed us to estimate the point of saturation. Saturation was reached after five sessions; we held one more focus group to confirm this. With the consent of participants, we recorded the focus group discussions and transcribed them verbatim. RJD made summaries based on the verbatim and the research notes taken during the focus group sessions. Participants were sent the summary and invited to review and make additions (member check). Only three students made use of this opportunity which resulted in minor adjustments to wording in our analysis. Three researchers (RJD, JvD, RES) iteratively read and coded the transcripts individually and independently. The emerging core themes were compared and any discrepancies were resolved by consensus. One researcher (RJD) identified, coded and analysed the themes and subthemes identified by JvD and RES using AtlasTi 6.2 software. A second researcher (RES) repeated the coding to enhance scientific rigour. The coding frame that developed was grounded in the data rather than decided a priori. The research team reviewed this coding frame and refined codes and categories through a process of constant comparison and axial coding. Codes were selected to illustrate the themes raised by participants and chose examples indicative both of typical responses and of the diversity of views obtained. We identified and discussed divergent examples within each theme. Identified subthemes were during the final stages of analysis considered in relation to relevant literature, for example work based learning.[34] Through this process of constant comparison we developed our emerging construct to answer the research questions.

Ethical approval

At the time of study, educational research studies reporting students' experience did not require approval from the ethics committee at Maastricht University. This study does not fall under the appropriate legislation concerning research on human subjects.

However, relevant ethical issues were carefully considered by the Department of Educational Research and Development. All participants received written information about the purpose and procedure of the study, and were recruited on voluntary basis. Students were informed they could leave the focus group session at any time. There were no adverse consequences for not participating; participation was voluntarily. We assured students that research data could not be traced to individual students, and that analyses would be used for scientific purposes only. All students gave informed consent and we have their signed agreement forms on file.

Results

We categorized the findings from the initial analysis of the data under related themes. In the following paragraphs, we will clarify the learning process as described by students in our focus group discussions. We will discuss our findings by answering the following questions,

- How do students describe the process of learning clinical skills in the workplace?
  - -What is learnt?
  - -How is it learnt?
- -Which factors influence this?

What is learnt?

Systematics: how and when to use physical examination skills

Students described that the way they use their skills changes when they reach the clinical stage of their curriculum. Students reported to be more attentive to the purpose behind the physical examination and would tailor their thoroughness according to the context, e.g. a full physical in emergency department or a condensed version for pre-operative check. This approach is in contrast to earlier years, where doing a physical examination merely involved doing the right things in the right order according to the guidelines provided by the Skills Lab. They said to use the steps learned in Years 1-3 as stepping-stones in their patient encounters.

"Yes, that's right [in the skills lab] you put your stethoscope on those five spots. And then you think 'I got that right!'. But now [in the hospital] you really think: 'okay, that's one heart sound, that's the second. Is there a murmur? Where is it? Is it systolic?" FG1P1

As it was not always clear what needed to be included in the physical examination and expectations varied amongst supervisors, some said the differences in required rigor caused confusion. Also, students reported to learn how to approach physicals in a sys-

tematic way so that a) they would not forget any step in the examination and b) they would not forget any findings. The expectations of the supervisor in reporting back findings are guiding student actions.
"Reporting back, I think, to the doctors. If you have seen a patient yourself and there is no supervision, then you report back and you give a brief summary of what you have seen. What you think is going on, the diagnosis and so on. I also think that helps a lot, because you get questions when it is not complete. Was the CVP increased? Oops, I didn't measure that" FG3P4

Agility
The agility with which students said to perform a physical examination increased, especially for difficult or intimate examinations. Depending on the clinical setting they were posted, students learned different aspects of the examination. Students made clear distinctions between the consequences of intimate examinations in the various hospital settings e.g. ward versus emergency department (ED). They realized that in ED a thorough physical is more important than on the ward. Students mentioned that patients on the wards were already examined before and there was little to be gained from yet another intimate exam. Non-invasive examinations such as auscultation of the lungs or heart were examples of types of skills that students mentioned to practice during their ward duty.

Recognition of Pathological Signs
A key learning outcome of their clinical rotations was the ability to recognize pathological signs. Students indicated to learn how to specifically be on the lookout for abnormal findings during physical examinations. They also described being increasingly more able to give meaning to these findings and how their ability to interpret them changed during their rotations.
"And the patient with ileus, I had never heard abnormal bowel sounds so you don't know what you're looking for. So you listen and think: is this it? And then you hear it once and then you will know just what you are hearing. So the next time you are performing abdominal auscultation you think; ah, these are normal bowel sounds, peristaltics." FG3P2

How is it learnt?

Students reported a wide variety of activities that contributed to their learning. Our analysis revealed a diverse range that upon closer inspection showed similarities to the work of Eraut who described ways of learning in the workplace.[34] We have derived the headings of our main themes from Eraut and adapted them to the workplace of the

clinical internal medicine department; working alongside others, tackling challenging tasks and working with patients.

Working alongside others

Learning by observation and developing your own way
Interviewees commented on the ways they learnt the correct procedures for physical examination. In relation to the preparatory training sessions held at the Skills Lab, students remarked that they experienced differences between the way they were trained to perform physical examination skills and the way they observed their supervisors act.

They mentioned that their adopted 'own best strategy' often resulted from the idiosyncrasies of their supervisors. That is, students felt they needed to know not so much the right way to do something but the way preferred by the supervisor. Students said to develop their own individual way of performing physical examination skills by comparing different examples and contrasting that with their own experience.

"So everytime I was shadowing a different doctor I thought, oh this one does it this way, that's quite handy. So you pick up different techniques every time by watching them and on the ward is where you can really put it into practice and see how it is. I really learned the most there." FG4P1

Learning by making findings explicit
Students mentioned that a strong motivator to execute the physical examination well was the prospect of having to report the findings back to their supervisor. They described to "force themselves" to do the exam carefully and with great attention – this was especially true when they received direct observation. Explicitly stating their findings – or doubts – enabled them to discuss the interpretation and to expand their understanding.
"No, what I often did, was listening to the lungs together and then he [the supervisor] *said well, describe what you are hearing. And that's just very helpful."* FG4P5

"But also because you have to write in the patient file and make it explicit what you've heard, so to say. That made me pay attention during auscultation, and already thinking about what I would write down later." P1FG1

Tackling challenging tasks

Learning through responsibility
Besides learning by making findings explicit students discussed the role of responsibility in their growing conscientiousness. The described change in students' attention towards abnormal signs during physical examination is influenced by two considerations. On the one hand they do this because they think it is expected since they will have to report back to their supervisor either verbally or in writing in the patient file. On the other hand students look for abnormal signs during physicals because this allows them to play an important role in the diagnostic process of the patient they see.
"After a few times examining patients under supervision, they all said; well I trust you, you can do that. And then you go to the next patient on your own and think: he is not going to verify my findings. Now I have to get it right." FG4P2

Learning through direct feedback by abnormal findings
During their time in clinic they say to build a personal archive of pathological findings that they extend in two ways. Either by being active in looking for these signs in patients they see and assertively asking for feedback on their findings or by being shown to them by their supervisors. This latter approach might mean both seeing a patient together and performing the physical examination with direct feedback, or being told by the supervisor to go and see a particular patient again on their own.

"And in the letter of introduction from the hospital it said: 'when you have nothing to do, call the resident at cardiathoracic surgery so you can go and listen to heart murmurs'. So when you called you went along with the resident performing ausculation on all patients who were scheduled for heart valve surgery the next day." FG4P4

Learning by taking initiative/being assertive/proactivity
Students also reported more specifically on the role of assertiveness in asking for feedback or supervision. When there is little encouragement from supervisors to discuss findings and to verify doubts, this may lead to uncertainty about the correctness of their execution of physical examination skills. Reasons for this include insufficient time or access to the supervisor. When confronted with such a situation, most students expressed hesitation to actively seek feedback due to lack of confidence to persist.

Students described how the nature of the tasks changed during their rotation. Some said to primarily see patients independently completing history and physical examination before seeking supervision while others reported spending much time on administrative tasks or simple procedure such as venapunctures. Taking responsibility often emerged through individual students' initiative, although the participants also

indicated that supervisor behavior was important as they provided them with the opportunity to engage in seeing patients at outpatient clinics or at ED and to undertake a full physical exam. This was seen to enhance both participation and learning. However this also brought the obligation of being clinically competent, or at least appearing to be. This seems to be a reinforcing cycle, whereby students with a proactive attitude are provided with more learning opportunities and increasing responsibility. Especially in departments with many students this may lead to a hierarchy of learners according to their level of proactivity, with students near the bottom needing experience but not getting it.

Working with patients

Learning by seeing, feeling, hearing
Students mentioned that seeing patients and being able to link patients' previous history and anamnesis with physical examination findings was a strong driver for learning. Through reflection on the findings, alone or with the help of a supervisor, students begin to construct an understanding of these clinical experiences. They begin to attach meaning to concepts they previously had no notion of or had difficulty comprehending. The opportunity to compare several patients in a relatively short time span helped them to develop the ability to distinguish between physiological (normal) and pathological findings.

"Like how a normal abdomen sounds, for that you have to have listened to many bellies. Here in the skills lab you may have examined one or two of your fellow students'. But to really be able to distinguish between normal and abnormal, you just have to do it [abdominal examination] *many times."* FG2P3

What factors influence this?

Factors associated with the physical examination itself
Students described mediating factors that helped them in their learning process of physical examination skills. One of the most frequently mentioned factors was the physical environment where learning takes place, e.g. outpatient clinic, ED or wards. Each setting has its own unique set of learning opportunities, but not all students were able to spend time in each. Students mentioned to use the differences in setting, patient population, delivery of care etc to practice different parts of their physical examination skills. They emphasized the effect of the role they are assigned during their rotation as contributing to their learning. Being able to contribute to the diagnostic

process by examining patients independently for the first time at the ED or outpatient clinic, provided strong incentives for learning.

"Well, it's often that there are many more things that you can detect at ED as compared to when a patient comes to the out-patient clinic. Then patients have already been seen by the GP or the patient is already known and comes for a follow-up visit. Then you have nothing more to find out, to discover, so to speak. While at the ED, you can find out much more by yourself and you're the first one to think, what is the could it be and what can we do. That's nice." FG4P2

"It's also because students see new patients and need to chart them. You can learn something from that. But with patients who have already been seen, then you are just repeating the examination. We've talked about this earlier, about repeating something that is already been done, but you learn more when you're actually doing something new." FG5P3

Supervisors can play a mediating role in this by clearly defining the role of students in their department and making sure necessary organizational needs are met (e.g. dedicated supervisor, patients scheduled for student consultation, own room). They can also facilitate students learning by encouraging them to 'tag along' during morning rounds to help interpret pathological findings. Students found teaching behavior that stimulates their engagement motivating, and offered examples of ways to include students in clinical encounters. Simple actions such as allowing students to examine the patient first versus observing the supervisor gives them an opportunity to reflect on the findings and challenge their ability to describe them appropriately.

"So if you have to really think about it or the answers are already laid out for you and you only need to go and check it, well yes indeed. That makes a lot of difference." FG4P1

The ability to recognize pathological findings depends on the opportunity to examine patients displaying these; this learning is largely serendipitous by nature. Often it is left to individual proactivity to look for interesting cases. However, students offered examples in which this type of learning was offered in a systematic and planned fashion, e.g. during morning rounds.
"We really had to go and, hey I hear that a patient was admitted here with an ileus and then you'd better go there and take a look." FG1P5

Related to an individual learners characteristics

Our focus groups revealed that learning is hampered by uncertainty resulting from students seeking their place and position in the department. A wait-and-see attitude results from students being preoccupied with questions such as "am I doing things right?". They kept themselves in the background, often to the advantage of those with a proactive attitude. In departments with many students, or sixth year students, this leads to lost learning opportunities when a 'queue' of learners forms with the more senior or proactive monopolizing interesting tasks.

"Because then you have to go to the ED, but during the day there is normally one student assigned there and then maybe also someone else doing late shift. So they are scheduled in that department and when there are patients they are the ones who are actually supposed to see them. So you have to deal with that." FG5P4

Factors influencing students' confidence in detecting abnormalities during physical examination are already mentioned above, namely the opportunity to build a personal frame of reference or archive and direct feedback when there is uncertainty. In addition to those factors, our interviewees identified another barrier to their learning. In the focus groups they called it 'proactivity', 'assertivity' or 'being forward'. Irrespective of the terminology they all refer to the notion of being able to influence the outcome of events by ones individual actions. In other words; students who are able to speak up, offer to undertake tasks and actively seek participation are more likely to see a wide variety of patient cases. They will have had more opportunity to practice the execution of the physical examination and they will have seen a larger number and wider variety of abnormal findings. Moreover, student reported that supervisors often respond more favourably to 'outspoken' students (extravert, assertive, enthusiastic) and provide them more easily with learning opportunities.

"*When you heard for example that there was a patient with an interesting diagnosis or abnormal findings on physical examination, I would just go there, chat with them and ask whether I could do the examination again so you can learn from it."* FG6P2

"When I was charting patients and I was like, oh this might be an abnormal heart sound, you know I have a limited frame of reference so there was always someone who came along and would later explain it to me. But often you had to know who to ask and pick the right person for that." FG2P4

"Would you just listen if it is correct? That worked most of the time, then you would get some more experience. That makes you more confident, like, that you just know okay

this really is a murmur. But the thing is you really have to ask for someone, it's not that if you are actually going to be observed." FG1P5

Contextual factors

The contextual factors that influence learning of physical examination skills relate to overcoming the hierarchy of learners and by promoting proactivity. Incorporating the factors discussed earlier, contextual influences on student learning concern the physical context and social context of the clinical rotation.

The physical context refers to the physical setting in which learning takes place, and we have already discussed the differences between the outpatient clinic, ED and the wards. Students mentioned to benefit from all three settings for different reasons. As mentioned earlier, seeing new patients at the ED enabled students to work independently and with an actual contribution to patient care whereas seeing patients in the outpatient clinic was similarly challenging provided there was ample opportunity for feedback.

"I participated in the teaching outpatient clinic and when I saw a patient I was given my own room where I could work until I was finished and then I asked the consultant to come and have a look. But I could just as easily take my time and spend half an hour taking the history if I thought that was necessary. So I was given space and time there to do my own thing." FG5P2

On the ward, the focus of learning shifted from diagnostic skills to patient management skills which – although important – fall outside the scope of this study. The low-threshold availability of patients on the wards gives students plenty opportunity to compare different variations of physiology and pathology. While any of these types of learning can occur in any setting, students recognized that some contexts were more likely to provide opportunities than others. For example, some students explained the lay-out/arrangement at their hospital which had a designated room at the outpatient clinic for student use, where they could see patients on their own with ample time to do so and the possibility to discuss their findings with an approachable supervisor.

"Yes, that makes a real difference. With some doctors it's really nice, they count on you to be there and you get to see patients on your own and do everything yourself and discuss it. With others, well, you're just there, listening in." FG1P1

The social context refers to the ways the people involved in the rotation shape learning, attendings, residents, fellow students, and nurses. We have already pointed out some aspects of the social context, such as the hierarchy of learners and the role stu-

dents are assigned. Other influences include the effect of supervision and the proactivity discussed earlier.
Teachers can directly affect the learning outcomes by role-modelling or providing direct feedback. Also, the explicit invitation to participate in the work is an important aspect of the influence teachers can have. Students said they needed to feel valued and allowed to approach their supervisors; if these conditions are not met students may not participate fully and lose learning opportunities.

"It has to come from both sides. An assertive attitude is important, that will keep you busy for a while. But if it's all up to you, then at some point you will think, okay now I have done enough, I've had it, just leave it." FG3P2

Students reported a wide variety between the amount of introduction and guidance in their respective departments. Some said to have had no schedule and every day was open to do whatever they felt like, while others stated to have fixed rotation within the department while being assigned to a particular member of staff.
Overall, most students favored the structured context as it provides direction and stimulus. Some expressed the desire for more responsibility within their range of existing competence and development, as they sometimes felt under stimulated.
"Because it is quite easy to do very little. When you are not all that assertive by nature and you ask for it, you end up doing very little and some residents really pick up on that and just say: you can do this or you can go do that." FG2P1

Discussion

Relationship of principal findings with literature

This study set out to explore the learning process of physical examination skills during clinical rotations. We have identified the nature of the learning outcomes and investigated how the characteristics of the individual student and the physical and social context in which learning occurs influence this process. Students report to learn the systematics of the physical examination, gain agility and become able to recognise pathological signs. The learning process involves a combination of working alongside others and working independently with increasing responsibility for patient care. We will particularly focus our discussion on the variations between student experiences and the role of proactivity and participation in learning physical examination skills in practice as these findings will have the largest implication for current practice.

The observations made by our participants are in accordance with the notions of situativity theory.[35] Its key tenet of is that knowledge and thinking as well as learning are situated in experience. It stresses the social nature of learning, with emphasis on the importance of the participants and their environment as well as the evolving interaction between them.

Inter-student variation of experiences

Based on our focus group discussions there seems to be huge inter-student variation when it comes to clerkship experiences, an observation confirmed by other studies.[16,36-38] The characteristics of the student are a determining factor of the actual learning that takes place; this is especially true for how often they receive observed and unobserved feedback. This complex interaction between students and their environment means that the notion of 'curriculum' in the clinical context is a purely hypothetical one. A characteristic of workplace learning is that the education actually being offered (curriculum in action) does not overlap with the intentions of a formal educational programme (curriculum on paper). What students actually learn during their clinical rotations (experienced curriculum) is different again and will even differ between two individuals who share the same experiences.[39]

Proactivity

Proactivity emerged as a key factor influencing individual students' learning experiences. Our students reported difficulty in steering their own participation in the clinical workplace. Billet acknowledges the active role learners play in choosing how they participate and in what activities they participate.[40] To understand the personal relations between the learners and the social environment we need to highlight the work of Bandaru, whose social cognitive theory not only is consistent with the situativity perspective but also explains students' proactivity.[41] Central in his work is the concept of 'personal agency'; the belief that individuals can influence the outcomes of events especially if other people are involved. Therefore when engaged in tasks individuals 'cannot simply sit back and wait for the appropriate performances to appear' [42], they need to regulate their thoughts and actions to benefit from the ongoing events.

In order for students to be able to be proactive, and seeking out learning opportunities that will help them to obtain physical examination skills, they will need to develop self-regulatory behaviour. A central premise however, is that the students need to believe they can perform well. This belief is called perceived self-efficacy, and according to Bandura's theory people with high self-efficacy are more likely to view difficult tasks as something to be mastered than something to be avoided. Research in medical education has shown however that students display poor capacity for self-assessment[43,44],

whereas the transition into the clinical phase reinforces students' feelings of inadequacy.[45]

On the specific topic of physical examination skills, Mavis has reported that students with high self-efficacy were more likely to score above the mean OSCE performance compared to low self-rated students, however there was no significant correlation.[46]

Participation in learning

It could be tempting to conclude that the problem (and hence the solution) of being proactive about learning physical examination skills lies solely with the individual student. That is a fallacy. As we have shown, the tangible outcome of notions such as proactivity and self-efficacy is student participation in the workplace. It can therefore not be the sole responsibility of the student to make this happen.

There is much emphasis in the field of medical education on the central role of participation in learning. A model of experience-based learning shows that 'supported participation' is essential in clinical workplace learning.[15] One of the defining characteristics of ineffective workplace learning is lack of participation. This is where a learner seems passive, unwilling to learn or just does what he or she is told.[47]

Our findings suggest that once students are assimilated in the clinical department and have a supported role in the day-to-day functioning of the workplace they are more eager to engage. This is facilitated by having overcome the 'shock-of-practice'; the participants with more clinical experience (more completed rotations) stressed how some awareness of the expected code of conduct makes it easier to participate in the clinic.[48]

Dornan concludes that student participation is shaped by department-related factors and by students' "human interactions". Our results show similarities to his model, most notably when students elaborated on the student-supervisor relationship. Our findings suggest that supervision of physical examination skills during clinical rotations is scarce and mostly unobserved. Most of the time supervision is not based on direct observation but apparently inferred from vicarious information. Examples that were mentioned in our focus groups include the oral reporting of findings, or the written records in patient files. Previous studies have also suggested that supervision is a rather haphazard learning event.[49-51]

This synthesis reinforces the social nature of learning physical examination skills; no supervisor no matter how good can create a good learning environment without input from the learner. No student no matter how proactive can force learning to happen without the prerequisite support from the supervisor and the environment.

From our findings and their relationship with the literature we can derive implications for current practice.

Implications for current practice

The contribution of this study is firstly conceptual in nature by describing the learning process of physical examination skills during clinical rotations. It provides a better understanding of the complex nature of learning in workplaces and as such expands the existing literature on this topic in the field of medical education. Secondly, the results of our study allow us to discuss and analyse the quality of learning experiences during clinical rotations. Our contributions can be used to improve the quality of existing programmes and to guide the design and implementation of new ways to learn physical examination skills.

The implications of this study for current practice are threefold; on the level of the individual student, the level of hospital department and the level of university.
On the level of the individual student, our findings revolve around the interaction between the individual student and his environment in which participation is pivotal for learning. Educational interventions should encourage students to adopt a proactive attitude, take initiative to enhance their own learning and be responsible for their own performance. Possible examples include pre-rotation workshops in self-regulatory behaviour and proactivity. This strategy could be strengthened on the level of the department hosting the clinical rotation, by making practice more accessible to newcomers. Initially, students can be introduced into the clinical workplace by allowing them to observe (e.g. in an outpatient clinic), followed by allowing them to perform low-risk tasks (e.g. physical examination on the ward) or by letting them perform under close supervision (e.g. ED). Such a process highlights the importance of not simply assuming the level of competence based on years of training, but advocates for a learner-centred approach based on the actual level of competence a student has gained.

Our findings suggest that although the principles of supervision according to this model are somewhat present in clinical practice, they do not meet individual students' needs. Special attention needs to be given to ensure that students carry clinical responsibility according to one's means, without compromising patient safety.
One of the first steps to promote such a positive learning environment is to provide an effective initiation or orientation; this includes practical information, clarification of the roles of students and a clear description of the expectations that others have in relation to their performance.[52]
Good clerkship organization can be bolstered at the level of the university or course directors. Support can include faculty development courses[53], and the provision of the

preparatory workshops for students entering the clerkships.[54] Special consideration can be given to expectation management (both of clinical staff and students)[55] and alignment of educational goals to be achieved in the rotations.[56]
Other issues that need to be centrally organized to deliver a superior clinical programme, especially when using satellite hospitals or rural placements, include comprehensive quality assurance and feedback on performance of departments and individual supervisors.[57]

Limitations of the study

This study explored student experiences in a select population, namely one medical school. We acknowledge the limitations this design may have on the outcomes of the study. Our training programme for clinical skills in the preclinical phase is more integrated and extensive than that found in other schools.[58,59]
It has been demonstrated that our students enter the clinical phase of their curriculum with a better preparation and higher level of skills mastery than in school without, or with a different skills lab.[60] Although we recognize the effect this has on the generalizability of our findings, we accentuate that the actual deficiencies in clinical learning experiences may be underestimated as a result.
Secondly, we rely on self-reports to describe the learning process of physical examination skills. These are not gauged against any objective measurement of actual performance in practice. We are aware of the lack of external validity our approach causes. We have deliberately chosen to analyse the underlying process instead of focusing on outcomes, but we urge future research efforts to investigate this relation.
Nevertheless, we think self-reporting is a strength too, since the impact of various influences on practising behaviour will be mediated through self-perceptions.
Thirdly, the sample size of our focus group studies is small. The presence of theoretical saturation, coupled with the diverse range of reactions from our interviewees suggests that we have assured representativeness. We are aware that qualitative research brings about the issue of observer dependency during data collection, and confirmation bias during data analysis. By adopting the iterative process described in the Methods section we guaranteed scientific robustness.

Conclusions and future research

This study explores learning skills in clinical rotations; a previously neglected area of research in the field of workplace learning. Our findings suggest that although individual student experiences vary greatly between different hospitals, it seems that proactivity and participation are central drivers for learning. This study adds to a growing body of literature on the process of learning during the clinical phase of medical education.

Our results are especially relevant in light of existing interventions and current innovations aimed at improving the quality of clinical rotations.[61] Future research should focus on the actual performance of skills, as well as the role of preparation in pre-clinical years on the desired learning outcomes.

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CHAPTER 9

General Discussion

General Discussion

The studies in this thesis are aimed at gaining a better understanding of how medical students acquire clinical skills. In this final chapter the results of the six studies are summarized and discussed. The results will be discussed for the main research questions formulated in the introduction ***Chapter 1***: how do medical students acquire clinical skills and how do learning and teaching activities influence this process?
This chapter examines the strengths and limitations of the thesis, and will conclude with suggestions for further research and implications for current educational practice. It will follow the structure of the thesis by first discussing the role of skills teachers during training sessions, followed by an appraisal of ways for students to improve their clinical skills outside time-tabled training sessions. Thirdly, the teaching and learning of clinical skills during the clinical rotations will be considered.

Main Findings and Conclusions

Teaching and Learning Clinical Skills in the Skills Lab

In order to investigate how learning and teaching activities influence the learning process of clinical skills, we focused our studies to several dimensions of students' development. Firstly, we concentrated on learning skills in the first pre-clinical years of the curriculum. We investigated the role of skills teachers during training sessions at the Skills lab from the perspective of both teachers and students. The first studies, reported in ***Chapter 3*** and ***Chapter 4***, revealed that teachers in the Skills lab setting require different teaching skills than tutors or clinical teachers, for example linking skills material to clinical practice. This was confirmed from the perspective of students as well as teachers. Important teaching skills include the ability to encourage students to provide meaning and relevance to clinical skills taught. Furthermore, effective teachers adapt the educational setting (e.g., content of the training, level of depth and teaching method) to the needs of any particular group.

Learning Clinical Skills outside the Skills Lab

Chapter 5 and ***Chapter 6*** looked into the strategies used by students to improve their clinical skills outside time-tabled Skills lab training sessions. ***Chapter 5*** reports on a variety of activities students use to improve their physical examination skills. On average, students devote about 20% of self-study time to skill training with Year 1 students practicing significantly more than Year 3 students. Practice patterns shift from just-in-time learning to a longitudinal self-directed approach. Simulated/real patients provide strong incentives to practise physical examination skills, initially causing confusion and

anxiety about skill performance but leading to increased feelings of competence. Early patient contacts such as the ones in year 3 make students feel more prepared for clinical practice in their hospital rotations. ***Chapter 6*** provides more insight in the practice habits of medical students, focusing on the use of one particular strategy namely deliberate practice. Students show progressively more planning behaviour and an increased tendency to structure their work across years. Furthermore, we found a positive relationship between OSCE performance and some aspects of deliberate practice suggesting that deliberate practice is an efficient strategy to hone clinical skills.

Teaching and Learning Clinical Skills in the Hospital

The final studies, ***Chapter 7*** and ***Chapter 8***, focused on the hospital-based clinical rotations and how students learn clinical skills in this environment. ***Chapter 7*** consists of a comprehensive literature review that appraises published studies on this topic. Two main conclusions can be drawn from our analysis. Firstly, clinical skills education in workplaces can be improved upon by supplementing it with more intensive education or substituting education in a training setting for workplace education. Secondly, settings and instructors are interchangeable; outpatient settings can take the place of inpatient ones, community sites are interchangeable with one another and with skills laboratory education, and instructors are interchangeable too. ***Chapter 8*** revealed that learning skills in the hospital workplace is perceived as a complex process. It is based on interplay between the student's learning attitude, the culture of the learning environment and the availability of supervision. The learning process involves a combination of working alongside others and working independently with increasing responsibility for patient care. Students report to learn the systematics of the physical examination, gain agility and become able to recognise pathological signs.

General Discussion

The results of this thesis contribute to a better understanding of how students learn clinical skills. As discussed in the Introduction section, medical educational research in general lacks studies that focus on "*how and why did it work*", i.e. studies with a clarification purpose[1]. The studies presented in this thesis focused on clarifying the process of skills acquisition and in charting the underlying factors affecting learning. This discussion will relate the principle findings to existing educational literature.

Mastering the Art of Medicine: Acquiring Clinical Skills and Expertise Development

The Skills lab model by Scherpbier & Metz has been discussed before as the foundation on which clinical skills teaching is based.[2] However, this model merely provides an outline of the educational principles for skills teaching. It fails to explain how to opera-

tionalize the different stages. The first studies in this thesis provide empirical evidence on what instructional methods in training sessions are most useful. More specifically, the outcomes of ***Chapter 3*** and ***Chapter 4*** show that the educational setting of clinical skills training (e.g. content, level of depth and teaching method) should be tailored to individual students' needs. This implies that students in Year 1 have different needs than those in Year 3. Additionally, our findings indicate that the most useful pedagogical methods actively engage students in their learning and encourage them to provide meaning and relevance to the skills taught – regardless of year of training. As students progress through their curriculum, the need to include the formulation of differential diagnosis and detection of underlying pathology arises. Implementing these guiding principles in educational practice would lead to changes in the way skills lab training sessions are structured. Tangible examples include embedding skills training in underlying basic science knowledge and linking skills to clinical practice by explaining implications of findings. These suggestions are well matched to the current insights in diagnostic reasoning, which show that findings on physical examination play a central role in both non-analytic and analytic reasoning.[3-7]

It also provides evidence for the assumption that students progressively integrate their knowledge and skills when problem-solving. As such, our findings suggest that early introduction of skills training contributes to the development of competence in performance of physical examination in real clinical practice. This complements the emerging literature on real patient learning and early clinical experience.[8-10] With medical schools exposing students to real patients early on in their curriculum, it is essential to provide them with the necessary skills to examine patients. Not only is this recommendable from an educational perspective, it also assures the need to guarantee patient safety. As alluded to in the introduction of this thesis, physical examination is a powerful clinical skill when used properly.[11-13] Especially with novice medical students examining real patients, it is self-evident that they need to be well-prepared. As Verghese noted, "*we do want to be sure that when people write in the chart "reflexes intact" or "cranial nerves intact" or "S1 and S2 heard, no m or g" that it is not a form of fiction, but represents an accurate observation*."[14]

Additional attention should be paid to enable students to actively engage in their learning. Our findings indicate that skill lab teachers should aim to develop students' ability to identify their own educational needs. Precisely how this is done was not the focus of this thesis and merits further research but some suggestions can be derived. If students are provided with the means to take responsibility of their learning and become self-directed, teachers and teaching activities can specifically target these needs. As such students are enabled to take appropriate actions to fulfill these needs and can optimize their own learning process. These results are in line with the proposed model of exper-

tise development and can provide a means of supporting students in their acquisition of clinical skills.

These notions on the importance of promoting self-directedness are reinforced by the outcomes of our studies on the practice habits of students outside time-tabled training sessions. As ***Chapter 5*** illustrates, students in different years display different learning activities with year 1 students spending more time practicing than year 3 students. Our analysis in ***Chapter 5*** and ***Chapter 6*** shows that students in later years exhibit different practice patterns and start to incorporate aspects of deliberate practice in their approach. However, in order to develop the most effective study habits students may require guidance in identifying areas where further practicing is needed and the next steps to be mastered. In short, teachers can play a facilitative role in the development of students' practice habits. Their feedback is essential in guiding the selection, sequencing and form of practice activities. These findings in the reality of medical students' learning fit with the theoretical principles laid out by Ericsson.[15] Moreover, they support the currently emerging discourse of learning as a social activity, which acknowledges the situatedness of learning in practice and appreciates the influences of the workplace environment.[16-18]

Once students have mastered the basic principles of skills either in Skills lab sessions or via self-directed learning, they are able to use these skills on real patients during their clinical rotations. As ***Chapter 7*** and ***Chapter 8*** show, interacting with real patients during regular clinical activities aids students in their learning of clinical skills. However, ***Chapter 8*** illustrates that this is a largely informal process of observation with very limited supervision and dedicated teaching by clinicians. The assumption that students learn clinical skills by simply being present in patient care is false. This 'learning by osmosis'[19]; is not the most optimal way of acquiring skills. Conversely, a gradual assumption of clinical tasks and increasing partaking provides students with opportunities and motivation to learn skills. However, even in a supportive environment individual student proactivity is still a key factor influencing both quantity and quality of the learning experiences. Dornan et al. have developed a model that builds upon the central role of active participation in learning[20]; this might also be applicable to learning clinical skills. The notion of 'supported participation' merits special attention[21], as this might be the optimum condition for self-directed students to achieve competence in skills with the guidance of experienced practitioners.[22,23]

Teaching and Learning Clinical Skills: Role of Teaching and Transfer

From this discussion several further conclusions can be derived, pertaining to the organization of skills training in the curriculum.

Organization of skills training in the curriculum

From the first studies, described in ***Chapter 3*** and ***Chapter 4***, it becomes clear that attention must be paid to horizontal and vertical integration when organizing a skills curriculum as preparation for clerkships. Both students and teachers commented on the importance of aligning skills lab activities with other course components. Suggestions for practice include the incorporation of physical examination skills and findings into cases addressed during PBL tutorials (horizontal integration) and refreshment courses to keep up important skills across years (vertical integration). Our findings support early introduction of skills training in medical education and build-up throughout the curriculum. Longitudinal integrated skills training could facilitate a student's ability to perform these skills in the clinical workplace. As ***Chapter 5*** and ***Chapter 6*** show, skills instruction outside workplaces (i.e. in skills labs) and experiential learning within them can supplement one another. Additional research should focus on the implementation of curricular measures based on these findings to facilitate transfer of clinical skills between skills lab and clinical environment. The instructional method 4C/ID developed by van Merrienboer addresses the issue of how to teach complex skills and might be useful in designing clinical skills education.[24]

Strengths & Limitations

In light of this discussion on the main outcomes of this thesis and its applicability in current educational practice, it is sensible to clarify the strengths and limitations of the research conducted.
The most important strengths of dissertation are the research methodologies used, the richness of the data we gathered and the relevance of the outcomes for educational practice. The main limitations are related to generalisability of the outcomes to other contexts and possible biases.

Strengths

The research methodologies used add to the strength of this thesis. The research questions presented in this thesis were investigated using both exploratory and explanatory study designs. Chapters 3, 4, 5 and 6 report on studies using an exploratory design, with qualitative methods followed by quantitative methods. ***Chapter 3*** and ***Chapter 4*** explore the views of students and teachers on effective teaching of clinical skills using focus groups and individual in-depth interviews respectively. Each methodology was chosen for its intrinsic strength. Focus groups can elicit a wide variety of opinions and include multiple viewpoints, while individual interviews keep interference of group dynamics and interaction between participants with research outcomes minimal. A total of 30 students participated in focus groups discussing what teaching activities

helped them to acquire clinical skills. Exploring the perspective of teachers through in-depth interviews verified these findings and yielded further insights in what constitutes good clinical skills teaching. ***Chapter 5*** and ***Chapter 6*** build upon these findings by mixed-method studies. These chapters combine questionnaires to assert student behaviour when practicing skills with focus groups that additionally illuminated these quantitative findings. Chapter 5 is based on focus-group sessions with 52 students from years 1-3 discussing what activities students undertake outside timetabled training sessions to improve their clinical skills. The questionnaire used in Chapter 6 was completed by 90% of all students in years 1-3 (n=875) giving reason to assume the findings are likely to be valid. For the studies presented in ***Chapter 7*** and ***Chapter 8*** explanatory design was used. Chapter 7 report on the findings of an extensive literature review with a comprehensive search strategy. This in turn informed the qualitative study in Chapter 8 that aimed to illuminate the learning process of clinical skill during clerkships. For this study, 32 students who had recently finished their internal medicine rotation participated in six focus group sessions. Again, this approach allowed for a wide range of reactions assuring representativeness of diverging experiences.

The use of multiple qualitative approaches produced a richness of data on teaching and learning clinical skills. Several preventions were taken to safeguard the trustworthiness of the final findings presented and to avert false conclusions.
Firstly, we did not decide a priori on the number of (group) interviews but instead ensured that data saturation had been reached before ending data collection.
Secondly, we used member-checking to verify entirety and completeness of the findings.
Thirdly, we adopted an iterative process of data analysis to guarantee scientific robustness.
The strong focus on the authentic context of teaching and learning strengthens the finding and offers the additional advantage of practical implications for educational practice. The wealth of information presented offers valuable lessons to students, teachers, hospital departments and medical schools about their contributions to the learning process of clinical skills. The qualitative studies show ways in which optimal learning experiences can be created, both in pre-clinical (skills lab) and clinical medical education.

Limitations
This thesis explored the learning and teaching activities of clinical skills in a select population, namely one medical school. We acknowledge the limitations this design may have on the outcomes of the studies. Although the potential effect on the generalizability of these findings needs to be recognized, it may be that actual deficiencies in

learning experiences in other contexts may be underestimated. Our training programme for clinical skills in the preclinical phase is more integrated and extensive than that found in other schools.
Secondly, qualitative research brings about the issue of observer dependency during data collection, and confirmation bias during data analysis. Since the main researcher was a medical student at the time of conducting the studies presented here, several measures were taken to prevent preconceptions and experiences affect the research process. During data collection, experienced moderators outside the research team conducted the focus groups based on pre-determined interview guides. During data analysis, an iterative process during involving all members of the research team guaranteed scientific robustness.

Suggestions for further research

This thesis aimed to increase our understanding of the process of teaching and learning clinical skills. Based on the studies presented, areas for further research can be identified. Future research should focus on the actual performance of skills, both in Skills lab training as well as during clinical rotations. There is a need to investigate innovative assessment of clinical skills, such as the use of formative methods in clinical rotations. The role of preparation in pre-clinical years on desired learning outcomes merits special attention. The use of early patient contacts and their benefits for skills training need to be clarified. Also, these contacts offer opportunities to study diagnostic reasoning in relation to clinical skills training. Other possible research questions concern the length of contact within the preceptor/mentor relationship and the opportunity for practice and feedback. How do we best support students to learn these clinical skills in the workplace? What does that support look like and how does the role of preceptors work? Longitudinal research following cohorts of students as they develop into medical specialists could help to identify factors stimulating and impeding the learning of clinical skills. Moreover, the role of skills labs in adjunct to students' engagement with real patients needs further clarification.

Implications for current practice

This thesis aimed to produce research with meaningful outcomes, in the sense that it has practical application, informs practice and will enhance our educational efforts. Our findings have the following implications for current practice.

Continuous Skills Training

Our findings suggest that a continuum model for clinical skills might be the optimal way of learning. Such a continuum model allows novices to become oriented to a certain skill and learn its basics, followed by a range of intermediate stages leading to learning from real-world situations of actual patients in the clinical workplace. Skills labs offer the opportunity to address elements that are challenging in actual patient care and ensure that they are aligned appropriately with the learners level. Learning from real patients can be used subsequently to build up an evolving set of skills and possible abnormal findings. The need for a continuum model is further illustrated by the findings that skills performance during clerkships can not only be improved by offering additional structured bedside teaching but also by non-authentic training on mannequins. The serendipitous nature of workplace learning with opportunistic experiences needs to be complemented with more structured skills training in clinical practice and/or training in a more controlled environment i.e. skills lab. Such degree of control allows training to be calibrated according to the level required by individual learners and to incorporate their specific clinical experiences with real patients.
From a practical perspective, this means that the current barrier between clinical and skills lab settings should become permeable i.e. allowing students to transition between skills lab to patient and back to skills lab. This implies a number of adjustments to current practice. Firstly, the skills lab trainings would seem to benefit from a more clinically oriented approach, including hypothesis-generating and clinical reasoning. This does not only boost student motivation to learn those skills, it also promotes transfer and enhances long-term memory by providing meaning and relevance. Secondly, students need to be able to go back to the skills lab during their rotations to work on specific skills according to their own learning needs. Their teachers should work with them to identify areas that need improvement and help them to set realistic learning goals. This requires students to be self-directed in their learning and teachers to be student-centred in their teaching. These two assumptions have further implications for practice, namely the need for student support and the need for teacher support.

Support for Teachers

The findings of this thesis are useful for faculty development, as these studies suggest that teachers in Skills labs need distinct didactic qualities. It shows that in order to teach effectively, teachers need the ability to adapt to varying conditions and to draw on a wide educational repertoire. New teachers should be provided with support, training and guidance in order to master these techniques. A thorough schooling of clinical skills teachers should be mandatory; it is clear from this thesis that teaching in skills lab

is a special teaching role and as such requires targeted training and support. In addition, our findings suggest that teachers value feedback from students and colleagues; this might be promoted through a formal evaluation procedure for formative purposes.

Passion for teaching emerged as a key characteristic for skills teachers in skills labs and both students and teachers commented on the crucial role enthusiasm plays. Chapter 8 elaborates on the importance of the student-supervisor relationship during rotations and its role in stimulating students to participate in clinical duties and learning clinical skills.

The implications of these findings for staff recruitment and retention (human resource management) are evident; universities should encourage talented teachers to teach clinical skills, and good teaching should be rewarded. Unfortunately, the academic triad of research, patient care and teaching is subject to erosion. Current higher education policies lead to an environment in which education must compete with research and clinical practice for resources. In such a climate, where talented individuals are constrained by performance evaluations based on their ability to obtain external research grants or deliver cost-effective patient care[25-27], it is even more vital to promote 'teaching' as a viable career option. Tenure track decisions should observe the literal meaning of the word 'professor' and only honor individuals with demonstrable teaching competency to carry that title.

As Hippocrates noted, and medical graduates in many countries echo when they take his eponymous oath*[3]; teaching is a core responsibility of doctors.**[4]
Based on this assumption, all clinicians should have sufficient knowledge of learning processes and supervision. A thorough understanding of the underlying principles of clinical education is a prerequisite for changing attitudes. Furthermore, training of trainers on coaching and/or supervising students should involve aspects of andragogy. Special attention should be given to supervision of actual performance of skills, providing feedback and incorporating basic sciences and clinical skills.

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*Part of the Hippocratic Oath, in the translation by Michael North of the National Library of Medicine reads:
"I swear [….] to look upon his children as my own brothers, to teach them this art; and that by my teaching, I will impart a knowledge of this art to my own sons, and to my teacher's sons, and to disciples bound by an indenture and oath according to the medical laws, and no others."[28]

**Moreover, the word 'doctor' receives its roots from the Latin verb 'docere', meaning 'to teach'.

Student Support

Students should be supported in developing their personal learning objectives by preparing them with 'soft skills' before they enter their clerkships. This entails assertiveness, time-management, communication, working in a team, etc. It also means that students should be sensitized to the principles of adult learning. Whilst building theoretical support for certain educational strategies (ie this thesis) is one way to move the field of medical education forward, it does not make those strategies and their use self-evident to students. We cannot expect our students to be masterful learners if we do not allow them to 'learn how to learn'.[30] Several approaches to overcome this hiatus in current educational practice can be envisioned, such as peer-assisted learning[31] and near-peer teaching.[32-34] These strategies are shown to have several benefits for both student-learners and student-teachers. The importance of why medical students should learn how to teach is best summarized by Dandavino et al[29]:

"- medical students are future residents and faculty members and will have teaching roles;

- medical students may become more effective communicators as a result of such training, as teaching is an essential aspect of physician–patient interaction;

- students with a better understanding of teaching and learning principles may become better learners. "

It may very well be that individual initiatives are already taking place, as is suggested in Chapter 5 on learning outside skills lab sessions and Chapter 8 on learning during clerkships. It seems that the experiences reported are part of the 'hidden curriculum'[35] ; an unintended side-effect of being a medical student. Still it is pertinent to formalize peer-teaching in the curriculum and to reward and appreciate it accordingly so as to make it part and parcel of medical school. In the current system, any individual with a medical degree is deemed qualified to teach. A subplot of this thesis conveys that this is not the case, and a plethora of other publications concur.[36-39] Even 100 years ago, Sir William Osler, who was referred to in the introduction as the 'father of modern medicine', highlighted the importance of teaching skills.

"*The successful teacher is no longer on a height, pumping knowledge at high pressure into passive receptacles. The new methods have changed all this. He is no longer Sir Oracle, perhaps unconsciously by his very manner antagonizing minds to whose level he cannot possibly descend, but he is a senior student anxious to help his juniors."*[4]

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CHAPTER 10

Summary

Background

Clinical skills are important for every competent doctor and their first use has been described thousands of years ago. The teaching of these skills however has not changed much over time, even though the practice of medicine has undergone dramatic changes. The traditional model of learning by watching a master at work has gradually been replaced in the past century with more engaging approaches. A particularly popular method for learning clinical skills has rapidly gained ground in medical education since its introduction in the early 70s. This innovation, alternately called clinical skills centre, skills laboratories or skills labs, provides students with the opportunity to learn and practice skills in a safe environment under the guidance of expert teachers.

Previous research has shown that these skills labs are essential to help students acquire clinical skills. However, the current approaches for teaching in skills labs are not well documented, and current practice lacks insight into students' strategies to learn the skills before they start seeing patients in their clinical rotations. Studies suggest that these rotations are not very effective and efficient in providing students with the needed learning experiences to become competent in clinical skills. Furthermore, existing literature fails to explain how skills are best learnt and taught in the hospital, and the underlying factors affecting the learning process remain unclear.

In light of these gaps in the existing literature, this thesis aims to enhance our understanding of the process of learning clinical skills. In particular, the main research questions are: how do medical students acquire clinical skills and how do learning and teaching activities influence this process?

The present thesis consists of 10 chapters. Chapter 1 contains the theoretical background to the studies and the research questions. Chapter 2 describes the context of the studies, the Skills lab at Maastricht University. Chapters 3 to 8 describe the various studies that aim to answer the research questions. In Chapter 9 the conclusions of these studies are discussed. This chapter, Chapter 10, will summarise the main findings of the research and provide an overview of the studies in the thesis.

Main Results

In order to investigate how learning and teaching activities influence the process of clinical skills acquisition, the studies in this thesis focused on several aspects of students' development. Firstly, concentration was on learning skills in the first pre-clinical years of the curriculum. This was investigated through examining the role of skills teachers during training sessions in the skills lab from the perspective of both teachers and students. Secondly, the activities students undertake outside these time-tabled sessions and outside the skills lab to improve their clinical skills were studied. Thirdly, the development of students' learning of clinical skills during the clinical rotations in the hospital was considered.

Teaching and Learning Clinical Skills in the Skills Lab

The first studies, reported in **Chapter 3** and **Chapter 4**, used a qualitative approach to explore the role of skills teachers during training sessions at the Skills lab. **Chapter 3** is based on a focus group study with students from the pre-clinical years 1-3. A total of thirty randomly selected students took part in two sessions each, discussing what teaching behaviour helped them to acquire physical examination skills. The results showed that the teaching skills and behaviours that most facilitate student learning of physical examination skills are interpersonal and communication skills, followed by a number of didactic interventions, embedded in several preconditions. This study shows that teachers in the Skills lab setting require different didactic skills than tutors or clinical teachers, for example linking skills material to clinical practice. Students appreciated teaching that stimulates deep and active learning. Another important set of findings referred to necessary preconditions, including the integration of skills training with basic science teaching and linking of skills training to clinical practice.

Chapter 4 confirmed these findings from the perspective of the teachers. Individual interviews with Skills lab teachers revealed that important teaching skills include the ability to encourage students to provide meaning and relevance to clinical skills taught. Furthermore, effective teachers adapt the educational setting (e.g. content of the training, level of depth and teaching method) to the needs of any particular group. The results of this study suggest that effective clinical skills teachers should aim to develop students' ability to identify their own educational needs and to enable them to take appropriate actions to fulfill these needs.

Learning Clinical Skills outside the Skills Lab

Chapter 5 and **Chapter 6** looked into the strategies used by students to work on these needs outside time-tabled Skills lab training sessions. **Chapter 5** used a mixed-method approach, aimed at exploring what activities medical students undertake to improve their skills and factors influencing this. The results of a questionnaire completed by 90% of all pre-clinical students (n=875) were combined with focus group sessions with 52 students in total. Students reported a variety of activities to improve their physical examination skills. On average, students devote 20% of self-study time to skill training with Year 1 students practicing significantly more than Year 3 students. Practice patterns shift from just-in-time learning to a longitudinal self-directed approach. Factors influencing this change are assessment methods and simulated/real patients. Simulated/real patients provide strong incentives to practise physical examination skills, initially causing confusion and anxiety about skill performance but leading to increased feelings of competence. Early patient contacts make students feel more prepared for clinical practice in their hospital rotations.

Chapter 6 provides more insight into the practice habits of medical students, focusing on the use of one particular strategy namely deliberate practice. In a quantative cross-sectional retrospective study, pre-clinical students completed a questionnaire (n=875) on various aspects of deliberate practice. Statistical analysis yielded four factors that emerged as underlying the reported student behaviour: planning, concentration/dedication, repetition/revision, study style/self reflection. The results show that student scores on 'planning' increased over time, scores on sub-scale 'repetition/revision' decreased. Student scores on subscales 'planning' and 'concentration/dedication' in years 1 and 3 correlated positively with results on the clinical skill test, as did scores on subscale 'repetition/revision' in year 1.

Teaching and Learning Clinical Skills in the Hospital

The final studies, reported in **Chapter 7** and **Chapter 8**, focused on the hospital-based clinical rotations and how students learn clinical skills in this environment. **Chapter 7** consists of a comprehensive literature review that appraises published studies on this topic. It shows that evidence of types of skills that are acquired during clinical rotations vary in quality and quantity. Clinical skills education in workplaces was improved upon by supplementing it with more intensive education or substituting education in a training setting for workplace education. Moreover, settings and instructors were interchangeable; outpatient settings could take the place of inpatient ones, community sites were interchangeable with one another and with skills laboratory education, and instructors were interchangeable too. This review identified a need for more research,

especially on the role of teachers and feedback, and the level and nature of support provided to students in workplaces.

A qualitative study, **Chapter 8**, looked into those elements more deeply. Focus groups with students after their clinical rotation in Internal Medicine revealed that learning skills in the hospital workplace is a complex process. It is based on interplay between the student's learning attitude and the culture of the learning environment and the availability of supervision. The learning process involves a combination of working alongside others and working independently with increasing responsibility for patient care. Students report to learn the systematics of the physical examination, gain agility and become able to recognise pathological signs.

Conclusions

The results of this thesis contribute to a better understanding of how students learn clinical skills. The studies presented in this thesis focused on clarifying the process of skills acquisition and in charting the underlying factors affecting learning. The outcomes of this thesis provide useful information for instructional methods for clinical skills teaching, curriculum design and faculty development.

Clinical Skills Teaching

Our findings indicate that the most useful pedagogical approaches actively engage students in their learning and encourage them to provide meaning and relevance to the skills taught. This implies that skills training should include the formulation of differential diagnosis and detection of underlying pathology. Changes in the way skills lab training sessions are currently structured include embedding skills training in underlying basic science knowledge and linking skills to clinical practice by explaining implications of findings. Furthermore, our findings suggest that early introduction of skills training contributes to the development of competence in performance of physical examination in real clinical practice.

Curriculum Design

This thesis shows the importance of aligning skills lab activities with other course components. Our findings support early introduction of skills training in medical education and build-up throughout the curriculum in a continuum model, thereby removing the current barrier between skills lab and clinical settings. This allows students to transition between skills lab to patient and back to skills lab to work on specific skills according to their own learning needs. Implications for current practice include offering skills training in a more clinically oriented approach, including hypothesis-generating and clinical

reasoning. Other suggestions for practice include the incorporation of physical examination skills and findings into cases addressed during PBL tutorials.

Faculty Development
The findings of this thesis are useful for faculty development, as these studies suggest that teachers in skills labs need distinct didactic qualities. New teachers should be provided with support, training and guidance in order to master these techniques. Passion for teaching emerged as a key characteristic for skills teachers in skills labs and both students and teachers commented on the crucial role enthusiasm plays. Our studies emphasized the importance of the student-supervisor relationship during rotations and its role in stimulating students to participate in clinical duties and learning clinical skills. Faculty development for clinicians with teaching roles should focus on supervision of actual performance of skills, providing feedback and incorporating basic sciences and clinical skills.

Future research

Future research should focus on the actual performance of skills, both in skills lab training as well as during clinical rotations. There is a need to investigate innovative assessment of clinical skills, such as the use of formative methods in clinical rotations. The use of early patient contacts and their benefits for skills training need to be clarified and these contacts offer opportunities to study diagnostic reasoning in relation to clinical skills training. Other possible research questions concern the contact within the student/teacher relationship and how to best support students to learn clinical skills in the workplace. Longitudinal research following cohorts of students as they develop into medical specialists could help to identify factors stimulating and impeding the learning of clinical skills.

CHAPTER 11

Samenvatting [Summary in Dutch]

Achtergrond

Klinische vaardigheden zijn belangrijk voor elke arts en hun gebruik is reeds duizenden jaren geleden voor het eerst beschreven. De manier waarop deze vaardigheden worden aangeleerd is echter niet veel veranderd, ook al heeft de uitoefening van de geneeskunde enorme veranderingen ondergaan. Echter, het traditionele meester/gezel model van 'leren' door te werken onder een meester en zijn manier van werken af te kijken is de afgelopen eeuw geleidelijk aan vervangen door andere benaderingen. Een bijzonder populaire methode voor het leren van klinische vaardigheden is geïntroduceerd in de jaren zeventig en wint snel aan terrein in het medisch onderwijs. Dit zogenaamde 'skills lab' biedt studenten de kans om vaardigheden te leren en te oefenen in een veilige omgeving onder begeleiding van deskundige docenten.

Eerder onderzoek heeft aangetoond dat deze skills labs studenten helpen om klinische vaardigheden te leren. Echter, de huidige aanpak voor het onderwijs in skills labs is niet goed gedocumenteerd en het is onduidelijk welke strategieën studenten het beste kunnen gebruiken om vaardigheden te leren voordat ze patiënten zien in hun coschappen. Studies suggereren dat deze coschappen studenten onvoldoende in staat stellen om klinische vaardigheden te verwerven; de leermomenten die studenten krijgen zijn ontoereikend.
Verder is vanuit de bestaande literatuur niet te herleiden hoe vaardigheden het best geleerd en onderwezen worden tijdens de coschappen in het ziekenhuis, en de onderliggende factoren die het leerproces beïnvloeden blijven onduidelijk.

Gezien deze lacunes in de bestaande wetenschappelijke literatuur is dit proefschrift gericht op het uitbreiden van ons begrip van het leerproces van klinische vaardigheden. De belangrijkste onderzoeksvragen zijn: hoe verwerven medische studenten klinische vaardigheden en hoe beïnvloeden onderwijsactiviteiten dit proces?

Dit proefschrift bestaat uit 10 hoofdstukken. Hoofdstuk 1 bevat de theoretische achtergrond van de studies en de onderzoeksvragen. Hoofdstuk 2 beschrijft de context van de studies, namelijk het Skills Lab van de Universiteit Maastricht. De hoofdstukken 3 tot 8 beschrijven de verschillende studies die erop gericht zijn de onderzoeksvragen te beantwoorden. In hoofdstuk 9 worden de conclusies van deze studies besproken. In dit hoofdstuk 10 wordt een overzicht gegeven van de belangrijkste bevindingen van het onderzoek en een overzicht van de verrichte studies.

Resultaten

De studies in dit proefschrift zijn gericht op de vraag hoe studenten klinische vaardigheden aanleren en op welke manier onderwijsactiviteiten dit proces beïnvloeden. Verschillende dimensies van het leerproces komen aan bod. Ten eerste; het aanleren van klinische vaardigheden in de eerste jaren van het geneeskunde curriculum. Dit werd onderzocht door middel van het bestuderen van de rol van vaardigheidsdocenten tijdens trainingen in het skills lab vanuit het perspectief van zowel docenten als studenten. Ten tweede; de oefenactiviteiten die studenten ondernemen buitenom deze geplande skills lab sessies om hun klinische vaardigheden te verbeteren. Ten derde werd het leren van klinische vaardigheden tijdens de klinische coschappen in het ziekenhuis behandeld.

Leren in het skills lab

De eerste studies, beschreven in **hoofdstuk 3** en **hoofdstuk 4**, gebruiken kwalitatieve methodes om de rol van vaardigheidsdocenten tijdens trainingen in het skills lab te onderzoeken. **Hoofdstuk 3** is gebaseerd op een focusgroep studie met studenten uit jaar 1-3. Een totaal van dertig willekeurig gekozen studenten nam deel aan twee sessies per stuk, waarin besproken werd welke interventies van docenten hen helpen bij het aanleren van klinische vaardigheden. De resultaten tonen aan dat de didactiek en het gedrag dat het meeste bijdraagt aan het leren van studenten de sociale en communicatieve vaardigheden betreft. Studenten benoemden didactische interventies die het leren van lichamelijk-onderzoeksvaardigheden vergemakkelijken. Deze studie toont aan dat docenten in het skills lab andere kwaliteiten nodig hebben dan PGO tutoren of klinische docenten, bijvoorbeeld het koppelen van lesmateriaal aan de klinische praktijk. Studenten waarderen onderwijs dat actief leren stimuleert. Andere bevindingen betreffen noodzakelijke voorwaarden voor goed skills lab onderwijs, inclusief de integratie met basisvakken als fysiologie en anatomie en het koppelen van vaardigheidstraining aan de klinische praktijk.
Hoofdstuk 4 bevestigt deze bevindingen vanuit het perspectief van de docenten. Middels individuele interviews met skills lab docenten is gebleken dat belangrijke didactische vaardigheden onder andere zijn: studenten aanmoedigen om betekenis te geven aan geleerde lichamelijk onderzoeksvaardigheden, en deze relevant te maken door ze te koppelen aan de klinische praktijk. Bovendien, effectieve docenten passen de didactiek (bijv. inhoud van de training, het niveau van diepgang en lesmethode) aan aan de behoeften van een bepaalde groep. De resultaten van deze studie suggereren dat effectieve klinische vaardigheidsdocenten erop gericht moeten zijn studenten te helpen in het ontwikkelen van het vermogen om hun eigen educatieve behoeften te identifice-

ren en hen in staat te stellen passende maatregelen te nemen om aan deze behoeften te voldoen.

Leren buiten het skills lab

Hoofdstuk 5 en **hoofdstuk 6** rapporteren onderzoek naar de strategieën van studenten om aan deze leerbehoeften te werken buiten ingeplande skills lab trainingen. **Hoofdstuk 5** beschrijft een gemengde methode, gericht op het verkennen van de activiteiten die medische studenten ondernemen om hun vaardigheden te verbeteren en de factoren die dit beïnvloeden. De resultaten van een vragenlijst die door 90% van alle studenten uit jaar 1-3 (n = 875) werd ingevuld is gecombineerd met focusgroepen met 52 studenten. Studenten meldden een verscheidenheid aan activiteiten om hun lichamelijk onderzoeksvaardigheden te verbeteren. Gemiddeld besteden studenten 20% van hun zelfstudie tijd om vaardigheden te trainen waarbij jaar 1 studenten beduidend meer oefenen dan jaar 3 studenten. Het oefengedrag verschuift van just-in-time leren naar een longitudinale zelf-gestuurde aanpak.Factoren die van invloed zijn op deze verandering zijn toetsmethoden en gesimuleerde / echte patiënten. Gesimuleerde / echte patiënten stimuleren studenten om vaardigheden te oefenen. In eerste instantie veroorzaakt dit verwarring en onzekerheid bij studenten over hun bekwaamheid, maar uiteindelijk leiden (gesimuleerde) patiëntencontacten tot gevoelens van competentie. Vroege patiëntcontacten maken dat studenten zich beter voorbereid voelen voor de klinische praktijk van de coschappen in het ziekenhuis.

Hoofdstuk 6 geeft meer inzicht in de oefengewoonten van medische studenten, gericht op het gebruik van een bepaalde strategie, namelijk ‘deliberate practice’. In een kwantitatieve cross-sectionele retrospectieve studie hebben 875 studenten een vragenlijst ingevuld over verschillende aspecten van ‘deliberate practice’. Statistische analyse leverde vier factoren op die ten grondslag liggen aan het door studenten gemeld oefengedrag: planning, concentratie / toewijding, herhaling / revisie, studiestijl / zelfreflectie. De resultaten tonen aan dat de student scores op 'planning' in de loop der tijd toenemen, terwijl scores op de sub-schaal 'herhaling / revisie' afnemen. Student scores op de subschalen ‘planning' en 'concentratie / toewijding' in jaar 1 en 3 correleert positief met de resultaten van de klinische vaardigheidstest (stationstoets), net als de scores op de subschaal 'herhaling / revisie' in jaar 1.

Leren in het ziekenhuis

De laatste studies, **hoofdstuk 7** en **hoofdstuk 8**, zijn gericht op co-schappen in het ziekenhuis en hoe studenten in deze omgeving klinische vaardigheden leren. **Hoofdstuk 7** bestaat uit een literatuurstudie die de gepubliceerde studies over dit onderwerp be-

oordeelt. Het laat zien dat onderzoek naar vaardigheidsonderwijs op de werkplek schaars is en van wisselende kwaliteit. Klinisch vaardigheidsonderwijs tijdens de co-schappen wordt verbeterd door het aan te vullen met meer intensief onderwijs of het vervangen van een training in het skills lab door onderwijs op de werkplek. Daarnaast liet deze studie zien dat instellingen en docenten onderling inwisselbaar zijn om vaardigheden te leren; polikliniek en verzorgingsafdeling en huisartspraktijk zijn inwisselbaar met elkaar en met het skills lab, en docenten zijn onderling ook inwisselbaar. Er is behoefte aan meer onderzoek, vooral over de rol van docenten en feedback, en het niveau en de aard van ondersteuning aan studenten op de werkplek tijdens coschappen.

Een kwalitatief onderzoek, **hoofdstuk 8**, onderzocht die elementen diepgaander. Uit focusgroepdiscussies met studenten na afloop van hun co-schap Interne Geneeskunde blijkt dat het leren van lichamelijk onderzoeksvaardigheden in het ziekenhuis een complex proces is. Het is gebaseerd op interactie tussen het leren van de student, hun houding, de cultuur van de leeromgeving en de beschikbaarheid van supervisie. Het leerproces bestaat uit een combinatie van werken naast anderen en zelfstandig aan de slag gaan met toenemende verantwoordelijkheid voor patiëntenzorg. Studenten melden dat zij de systematiek van het lichamelijk onderzoek leren, behendigheid verkrijgen en geleidelijk aan in staat zijn om pathologische verschijnselen te herkennen.

Conclusies

De resultaten van dit proefschrift dragen bij aan een beter begrip hoe studenten klinische vaardigheden leren. De studies in dit proefschrift hebben tot doel het leerproces van lichamelijk onderzoeksvaardigheden te verhelderen en de onderliggende factoren die hierop van invloed zijn in kaart te brengen. De uitkomsten van dit proefschrift geven aanwijzingen voor effectieve educatieve methoden voor klinisch vaardigheidsonderwijs, verandering in curriculum ontwerp en implicaties voor staf training.

Vaardigheidsonderwijs

De bevindingen geven aan dat de meest effectieve pedagogische benadering is om studenten actief in hun leerproces te betrekken en hen aan te moedigen om relevantie en betekenis te geven aan de vaardigheden die zij aanleren. Dit houdt in dat vaardigheidsonderwijs ook het formuleren van differentiaal diagnoses en het opsporen van de onderliggende pathologie zou moeten bevatten. Veranderingen in de manier waarop skills lab trainingen op dit moment zijn gestructureerd betreffen o.a. de inbedding van vaardigheidstraining in de onderliggende fundamentele kennis van basisvakken als anatomie en fysiologie, en het koppelen van vaardigheden aan de klinische praktijk door implicaties van de bevindingen uit te leggen. Bovendien suggereren onze bevin-

dingen dat vroege introductie van vaardigheidsonderwijs bijdraagt aan de ontwikkeling van bekwaamheid in de uitvoering van lichamelijk onderzoek in de klinische praktijk.

Curriculum ontwerp
Dit proefschrift toont het belang aan van het afstemmen van skills lab activiteiten met andere opleidingsonderdelen. Onze bevindingen ondersteunen vroege introductie van vaardigheidstrainingen in het medisch onderwijs en de opbouw in het curriculum middels een continuüm model, waardoor de huidige barrière tussen skills lab en klinische praktijk verdwijnt. Dit geeft studenten de mogelijkheid om te wisselen van het skills slab naar de patiënt en terug naar skills lab om aan specifieke vaardigheden te werken volgens hun eigen leerbehoeften. Gevolgen voor de huidige praktijk zijn onder andere het aanbieden van vaardigheidstraining in een meer klinisch georiënteerde aanpak, met inbegrip van hypothese-genererend, differentiaal-diagnostisch en klinisch redeneren. Andere suggesties voor de praktijk zijn onder meer de integratie van lichamelijk onderzoeksvaardigheden en bevindingen met casus in PGO-werkgroepen.

Staf training
De bevindingen van dit proefschrift zijn nuttig voor staf training, aangezien deze studies suggereren dat docenten in skills labs disparate didactische kwaliteiten nodig hebben. Nieuwe docenten moeten worden voorzien van ondersteuning, training en begeleiding om deze technieken onder de knie te krijgen. Passie voor het onderwijs komt naar voren als een belangrijk kenmerk voor vaardigheidsdocenten in skills labs en zowel studenten en docenten benadrukten de cruciale rol die enthousiasme speelt. Onze studies benadrukten het belang van de student-supervisor relatie tijdens de coschappen en de rol van de supervisor in het leren van klinische vaardigheden en het stimuleren van studenten om deel te nemen aan klinische taken. Staf training voor clinici met onderwijsrollen moet zich richten op begeleiding van de daadwerkelijke uitvoering van lichamelijk onderzoeksvaardigheden, het geven van feedback en integratie van basisvakken en klinische vaardigheden.

Toekomstig onderzoek

Toekomstig onderzoek kan het beste gericht worden op de daadwerkelijke uitvoering van lichamelijk onderzoeksvaardigheden, zowel in het skills lab als tijdens de klinische coschappen. Er is behoefte aan onderzoek naar innovatieve toetsing van klinische vaardigheden, zoals het gebruik van formatieve feedback in de coschappen. Het gebruik van vroege patiëntcontacten en de voordelen daarvan voor het vaardigheidsonderwijs moet worden verduidelijkt. Daarnaast bieden deze contacten mogelijkheden om diagnostisch redeneren in relatie tot klinische vaardigheden te bestuderen. Andere

mogelijke onderzoeksvragen hebben betrekking op het contact binnen de student / supervisor-relatie en hoe studenten het beste te ondersteunen zijn op de werkplek om klinische vaardigheden te leren. Longitudinaal onderzoek naar cohorten studenten in hun ontwikkeling tot medisch specialisten kan inzicht geven in de factoren die van invloed zijn op het leren van klinische vaardigheden.

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CURRICULUM VITAE

Robbert Duvivier

Robbert Duvivier was born in 1984 and spent his childhood in Koudekerke, The Netherlands. After graduating from secondary school he spent a gap year abroad.
In 2004 he started his medical studies at Maastricht University, which he has completed in 2012 (MD). Alongside the clinical part of his medical degree Robbert has completed this PhD thesis.

Robbert has worked on medical education issues since the onset of his academic life on local, national and international level.
Locally, he was involved in the student council at the Faculty of Health Medicine and Life Sciences, Maastricht University and was student board member at the Institute of Medical Education. Furthermore, he co-organised the elective course "International Health and Tropical Medicine" which is taken by 150 second-year students and entirely organised by medical students. In 2011-2012, he was PhD representative on the faculty council.
Nationally, Robbert served as Vice President of **the International Federation of Medical Students' Associations The Netherlands** (IFMSA-NL) in 2005-06.
Internationally, he served as Vice President of the **European Medical Students' Association** (EMSA) in 2006-07. In 2008 he was elected Liaison Officer on Medical Education issues to the executive board of the **International Federation of Medical Students' Associations** (IFMSA). In this capacity he represented medical students on the executive committee of the **Association for Medical Education in Europe** (AMEE) and on the executive council of the **World Federation of Medical Education** (WFME) in 2008-2010. He worked with the **World Health Organization** (WHO) in their Reference Group on Medical Education as expert consultant in 2010. He worked as educational consultant in Sulaiman Al-Rajhi University in Bukairiyah, Saudi Arabia for two months to assist with the development of their new medical faculty.

Parts of his PhD thesis were written as a visiting scholar at the **Foundation for Advancement of International Medical Education and Research** (FAIMER) in Philadelphia, USA.

Robbert has written several articles, book chapters and other publications such as editorials and commentaries in journals as the *Lancet, New England Journal of Medicine* and *JAMA.* He serves on the editorial board of *Education for Health*; a peer-reviewed journal on international education in the health professions.
Robbert has travelled extensively on six continents and coordinated projects in Kenya (youth) and South Sudan (health promotion).
He hopes to combine his passions in a career in academia or with an international non-governmental organisation.

In his free time he enjoys long-distance running, photography and spending time with family and friends.

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