

# Clinical skills training in undergraduate medical education using a student-centered approach

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## THE 4 ORIGINAL PAPERS ARE

1. Tolsgaard MG, Gustafsson A, Rasmussen MB, Højby P, Müller CG, Ringsted C. Student teachers can be as good as associate professors in teaching clinical skills. *Med Teach*. 2007 Sep;29(6):553-7.
2. Tolsgaard MG, Arendrup H, Lindhardt BO, Hillingsø JG, Stoltenberg M, Ringsted C. Construct validity of the reporter-interpreter-manager-educator structure for assessing students' patient encounter skills. *Acad Med*. 2012 Jun;87(6):799-806.
3. Tolsgaard MG, Bjørck S, Rasmussen MB, Gustafsson A, Ringsted C. Improving Efficiency of Clinical Skills Training: A Randomized Trial. *J Gen Intern Med*. 2013 Apr 18. [Epub ahead of print]
4. Tolsgaard MG, Arendrup H, Pedersen P, Ringsted C. Feasibility of self-directed learning in clerkships. *Med Teach*. 2013 Feb 27. [Epub ahead of print]

## INTRODUCTION

High quality clinical training of medical students is of critical importance to the delivery of optimal and safe patient care. This training is traditionally perceived as being delivered by vertical teaching methods from teacher to student placing the responsibility of learning on teachers and faculty. Throughout the medical study, students are supposed to acquire knowledge, skills and professional attitudes [1]. In their clinical training, much time is dedicated to ensure sufficient clinical skills, defined as "any action, performed by a healthcare worker involved in direct patient care, which impacts on clinical outcome in a measurable way", including cognitive, non-technical, and technical skills [2]. How-

ever, medical students' clinical skills are often far from stakeholders' expectations [3-6], which calls for more effective training methods in undergraduate clinical medical education. However, focus has until now been primarily on the teacher and on instruments that may stimulate learning, whereas the learner has received less attention. An underutilized resource may prove to be the students themselves, as argued in the following section. In the following sections, prevailing strategies for clinical skills training are described and potential new concepts for improving clinical skills training discussed.

## Prevailing strategies for clinical skills training

Traditionally, clinical skills training takes place in skills labs and in clinical clerkships. Skills labs provide students the option of clinical skills training using dummies and simulated patients (i.e. actors acting patients). These centers provide highly structured teaching and students are able to practice their skills in a 'safe' environment as opposed to clinical clerkships, in which learning opportunities are not standardized or controlled. Moreover, skills labs ensure training of skills that students are not able to learn in practice (e.g. CPR skills). However, using clinical teachers in skills labs is expensive and recruiting a sufficient number of clinician teachers is a challenge to many clinical skills centers [7-9]. Further, students may have problems transferring the skills they learned into a clinical setting [10]. In conclusion, skills lab training is ultimately challenged by costs of training and the degree of transfer of skills to patient care.

Taking these limitations of skills lab training into account, training in clerkship remain core to clinical medical education. An important advantage of training skills in clerkships is that the place of training and future practice is the same, producing fewer problems regarding application of skills. However, teaching and learning in clerkships have been characterized as random and opportunistic [11,12] and students are often un-supervised in their activities with a low frequency of feedback [13]. On top of this, the increasing number of medical students has been a subject of concern as this may have detrimental effects on student learning in clerkships [14-16]. Several initiatives to improve learning have been attempted but clinical skills training remain difficult to improve [17, 18].

During the last decades, research in undergraduate basic science education has included initiatives that rely on active participation of the student in their own learning. These strategies have the several attractive features including the potential to develop the skills required to effectively address clinical problems [19]. Student-centered approaches to clinical skills training have until now received little attention although these methods seem attractive to deliver and maintain high-quality medical education.

### **A student-centered approach to learning**

Student-centered initiatives have been used in pre-clinical undergraduate medical education since implementation of Problem-Based Learning (PBL) at McMaster University in the late 1960's. PBL was implemented as a way to educate graduates, who 'had the skills to deal with the information explosion through self-directed learning, information search and retrieval skills, critical appraisal, and self-assessment' [20]. Since then, student-centered approaches to pre-clinical medical education have been extensively explored [21-25]. The underlying theory behind PBL is that it facilitates "acquisition of generic competences, encourages a deep approach to learning and prepares students for the adult learning approach they need for a lifetime of learning in the health care professions" [26]. However, PBL was intended only to prepare students for their clinical clerkships in the first years of undergraduate basic science teaching [27,28] and current views consider formal PBL teaching to end as the students enter clinical clerkship [19]. Until now little attention has therefore been given the use of student-centered and peer-assisted approaches to learning in the clinical part of undergraduate education.

### **Peer learning**

Students may be able to learn through the same principles of self-direction and interaction with peers in settings outside the classroom. The concept of peer-learning, as described by Topping [29,30], is anticipated to mediate several desirable effects through a partnership in learning between students. Peer-learning can be defined as 'the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions' [30]. This includes peer tutoring, also known as peer-assisted learning, which traditionally has been perceived as the more able student helping the less able student while enacting the role of a surrogate teacher. An acknowledged definition is provided by Topping describing peer-assisted learning as 'people from similar social groupings who are not professional teachers helping each other to learn and learning themselves by teaching' [29]. Peer-assisted learning is used in a variety of settings within the field of medical education including teaching theory, technical skills, musculoskeletal and physical examination in both skills labs and in clinical settings [31, 32]. Peer teachers generally receive good evaluations regarding learners' satisfaction with the teaching and they are especially praised for being good in giving feedback and understanding the learning difficulties of their peers [7, 8, 33-35]. Moreover, it appears that student performance on standard exams are not weakened by the use of peer teachers [7, 9, 35-38], although student teachers may not have the same pedagogical expertise pertaining to procedural knowledge as clinicians [39]. The positive effects are thought to be mediated through a task level difficulty that is within the learner and teachers zone of proximal development [29, 40] in terms of an apprenticeship in thinking [41]. Further, the beneficial effects of peer-assisted learning are not restricted to the learner but may also extend to the teachers.

Existing literature has primarily focused on peer-assisted learning as an adjuvant to traditional training and the typical peer-teacher is a senior student volunteering for teaching junior students [42]. It is not known whether the teaching provided by student teachers is as good as that provided by associate professors. To deliver high-quality cost-effective teaching in skills labs, this is a question not only of theoretical relevance but also of practical importance. Hence, one of the aims of this thesis is to assess the quality of basic clinical skills training delivered by student teachers. Using

the term 'basis clinical skills' implies that clinical skills as a concept comprise a continuum of characteristics and features. Thus, to improve clinical skills training on different levels, knowledge about how clinical competence develops is necessary.

### **Development of clinical skills competence**

Little attention has been given to exactly how students develop their clinical skills. Concepts of development of competence may serve as useful conceptualizations to understand how students may be optimally trained. Some theories appear useful to describe the development of expertise [43] and others theories help us understand taxonomies for learning [44]. The Reporter-Interpreter-Manager-Educator (RIME) framework combines these aspects and may well describe how learning and competence develops in clinical clerkships, where it is used to evaluate student performance [1]. The nature of this framework is 'developmental' as it reflects progression in clinical competence from novice to expert through four stages: the level of gathering information (Reporter), analyzing and prioritizing patient problems (Interpreter), managing a plan for the patient (Manager), and demonstrating reflection and education of others (Educator) [45]. The RIME framework is popular among students and faculty [46,47] and is considered reliable for in-training assessment purposes [48]. The ease of relating the framework to Bloom's taxonomy of learning [44] may explain its popularity as the four elements represent a framework of progressively higher cognitive skills achieved by the learner—that is, from data gathering to analysis, synthesis, and evaluation [49].

However, whether the RIME framework does reflect progression in competence is not known. The question is interesting for two reasons. First, empirical evidence is needed that the RIME framework in fact fits as an explanatory model for the development of competence (e.g. clinical skills) to justify its use as theoretical model of skills acquisition. This is important as student-centered initiatives – such as peer-learning principles – are founded on the idea of students as partners in thinking due to same developmental stage of clinical expertise. Second, establishing 'construct validity' of the RIME framework in terms of demonstrating progression in competence enables its use as an assessment instrument for students' learning and for future studies involving student-centered interventions. Thus, the concept of construct validity of the RIME framework will be further explored in this thesis. Using this new knowledge about development of competence enables the issue of peer-learning to be re-visited, now focusing on complex clinical skills training.

### **Peer-learning strategies for complex clinical skills training**

One hypothesis of peer-learning is that students belonging to the same level of expertise may learn more easily from each other due to similar ways of thinking [30]. Whereas peer-assisted learning assumes a degree of role-taking with a learner being taught by a teacher, the term collaborative learning refers to an equal interaction between learners through positive interdependence [30,50]. As previously mentioned, this concept is well-known from peer-learning formats such as PBL or small group learning, which rely on interaction and reflection with peers. Literature from non-medical areas suggest that training in pairs, which is known as dyad training, is an effective and efficient way to train complex motor skills and that it has positive effects on other factors such as confidence and social aspects of learning [51-55]. In these studies, participants in dyad groups perform as well as or better than participants who train alone, despite having half the amount

of hands-on training time. However, dyad training has yet to prove useful in a medical educational context, such as clinical skills training. It may be an advantage when training complex clinical skills where students can share knowledge and thereby improve their learning outcome from each patient encounter. Results from one study on motor skills learning suggest that the advantage achieved from dyad practice is primary due to observation [54]. This correlates well to research in neuro-biology, where so-called 'mirror-neurons' are shown to be activated through acting and observation of the same action [56-58]. However, dyad training may not be an advantage in all areas, as it may hinder learning tasks that depend heavily on declarative knowledge [59]. On the other hand, initiatives that rely on student-interaction in basis science education – such as Team-Based Learning – are becoming increasingly popular. Thus, students practicing in groups given the individual and group responsibility of the learning achieve as high or higher exam scores and perceived engagement in the teaching than those taught using traditional teaching methods [60]. The critical difference between the concerns raised by Crook & Beier [59] and the positive reports on Team-Based Learning seem to rely on the degree of cognitive involvement required by the students, which in turn is dependent on the context of use. However, this has not previously been addressed using dyad training for clinical skills training. In conclusion, the theoretical concept of dyad practice may serve to solve a practical problem, as the increasing amount of medical students and the effects this has on students' clinical skills learning is a concern in recent literature [14-16]. One of the aims of this thesis is therefore to explore the effect of dyad training on clinical skills training. The interaction with peers in dyad learning and Team-Based Learning are both student-driven activities that are to some extent based on the concept of directed self-guided learning, which has gained recent popularity [61]. These concepts are subject for further exploration in the final study of this thesis.

### Self-directed learning in clinical clerkships

Whereas the previously discussed initiatives relate to how students may benefit from interaction with peers, the concept of self-directed learning has also drawn attention. Self-directed learning can be defined as 'an ongoing process through which individuals identify their learning needs, identify means to meet them, engage in relevant learning activities, and evaluate their progress and achievement in meeting their needs' [62]. Self-directed learning is known from pre-clinical PBL teaching to produce learning goals, facilitate comprehension of new knowledge, and provide attractive social effects for the learners [63]. However, if used in clinical clerkships, self-directed learning is reported to be a method of learning that students default to when support and guidance are lacking. Instead, students prefer supported participation in terms of active engagement in clinical problems with support from the preceptors [64, 65]. This lack of transfer from classroom to clerkship of self-directed learning behavior is explained by the motivational effects of uncertainty in a secure and safe setting as opposed to an unfamiliar clinical context characterized by complexity and power differentials [65, 66]. If self-directed learning should be used in a clinical context, some degree of direction and support is needed, as suggested by Brygdes et al. using the term 'directed self-guided learning' [67]. To improve students' clinical skills training Rolfe and Sanson-Fisher reviewed existing literature and identified principles underpinning effective clinical learning [68]. These included making active decisions, an individual focus to learning, gaining experi-

ence, feedback to the learner, feasibility, and cost-effectiveness. Based on these principles, research has shown that introducing feed-back cards in clerkships may increase the number of independent formulations of psychosocial / ethical and legal issues as well as suggestions for investigation and management plans made by students [69]. Throughout the last decade, a number of different encounter-cards have been described with varying results on feedback, learning, and student satisfaction [70-77]. In summary, patient encounter cards are feasible in many contexts but summative assessment or exclusive focus on feedback does not provide an advantage to learning. Instead, the encounter cards may serve as a structure to improve students' engagement in making formulations of patient diagnoses and corresponding differential diagnoses, management plans, and learning goals. This assumes that the encounter card forces students to take on the role of the active participant in clerkship and it also relies on some degree of autonomy in learning in terms of self-directedness of the student. A student-driven initiative may be a valuable adjunct in clinical skills learning if it encourages participation and preceptor involvement. Due to its desirable developmental aspects and previous positive student and preceptor evaluations [75], the RIME framework was chosen for further examination in this thesis.

### RESEARCH QUESTIONS

The focus of this thesis is how to improve clinical skills training in skills-labs and in clerkships using student-centered approaches. This includes new concepts of how student-driven initiatives may comply with the problems that contemporary medical education is faced with.

The main research question was:

- *How can a student-centered approach contribute to clinical skills learning in undergraduate medical education – in the skills lab and the clinical clerkship?*

Six research questions relating to four projects were generated. Each question is listed under the relevant study. The first study focused on examining if the teaching provided by student teachers was non-inferior to that provided by associate professors. The research question was:

1. *How do student teachers compare to clinical associate professors regarding the quality of procedural skills' teaching in terms of participants' technical skills, theoretical knowledge, and satisfaction with the teaching?*

The second study explored if the Reporter-Interpreter-Manager-Educator framework could be used for assessment of students patient-encounter skills. The research questions were:

2. *Do assessment scores on the four RIME elements progress according to students' increasing clinical experience?*
3. *How do clinician examiners in surgery and internal medicine use a RIME-structured scoring form in the oral examination of students' patient encounter skills, and what is the inter-rater reliability of the scorings?*

In the third study, the RIME framework was used to assess how dyad training affected students' patient-encounter skills in a randomized trial. The research questions were:

4. *What effect does dyad training of junior medical students have compared to single training, assessed by a performance test of patient management skills two weeks after the training?*

5. *What is the students' perception of the training format in terms of confidence in managing future clinical patient encounters and perceived advantages or disadvantages of dyad training?*

In the final study, the RIME framework was used as student-driven patient-encounter card to improve learning outcome in clinical clerkships. The research question was:

6. *How do year-four and year-five medical students perceive the feasibility and usefulness of a self-directed Clinical Encounter-Card in core clinical clerkships?*

## CONTEXT OF THE STUDIES

The studies in this thesis were conducted in the Centre for Clinical Education at teaching hospitals affiliated with the University of Copenhagen, Denmark. The medical program at the University of Copenhagen consists of a six-year traditional curriculum with basic science teaching during the first years and clinical sciences teaching and clerkship training during the last years. The program includes a large amount of didactic teaching in lectures and classes, and hardly any PBL sessions. All students have mandatory skills-lab training in patient encounter skills (history taking and physical examination) and basic clinical skills during their clinical years. Students have their core clerkship in year four and -five, comprising 40 weeks of internal medicine and surgery with end-of-clerkship exams (orals, written, and OSCE).

## STRUCTURE OF THE THESIS

This thesis is structured around four studies, in which student-driven initiatives are examined with respect to their ability to facilitate clinical skills learning in undergraduate medical education. In the first study, the effect of the teaching provided by student teachers is examined. To assess the effect of dyad practice, a discriminative assessment instrument was needed. Thus, the second study is a construct validation study of the RIME framework for assessing patient-encounter skills. From having a senior more able student teaching a junior in-experienced student, the third studies aim at exploring collaborative learning, i.e. how students may benefit from training in pairs instead of alone. Finally, the fourth study explores the effect of a student-driven initiative to improve participatory practice in clinical clerkships using a patient-encounter form structured according to the four RIME elements. The four studies are all published and referenced at the beginning of this thesis. In the following section, abstracts for each of the four studies are presented.

## STUDENTS TEACHERS CAN BE AS GOOD AS ASSOCIATE PROFESSOR IN TEACHING CLINICAL SKILLS [78]

### Background

Recruiting sufficient numbers of clinical teachers for undergraduate medical education is difficult and expensive [7,9]. The use of medical students as facilitators or teaching assistants is widely used and it has generally received good evaluations [33,34]. How-

ever, there is little evidence of the effectiveness of using student teachers compared to faculty as using student teachers has often been evaluated as an add-on to the teaching provided by faculty. The aim of this study was therefore to compare student teachers and associate professors with regards to the quality of procedural skills teaching in terms of student satisfaction, knowledge, and performance.

## Methods

This study was an experimental, controlled, randomized trial comparing student teachers and associate professors with regards to the quality of teaching. The student teachers were paid professional teachers working at the skills lab in the Centre for Clinical Education. The associate professors taught clinical skills on a regular basis and were renowned for being good clinical teachers. The participants to be taught were 71 first year medical students, who had not undergone any prior clinical skills training.

The procedures chosen for this study were IV access and bladder catheterization. Before the intervention, all participants were assessed in a practical pre-test using mannequins and checklists that were developed for OSCE examinations. They also completed a theoretical pre-test consisting of questions regarding knowledge of equipment, indications, and complications. Following the pre-tests all students were randomized to either being taught by associate professors or by student teachers. The teaching consisted of simulation-based training using low-fidelity mannequins in groups of six. One hour of teaching was provided for each skill. Following the intervention, all students were post-tested using the same tests as in the pre-test and they were asked to indicate their satisfaction with the teaching. Pre- and post-test scores were analyzed and compared between the two groups using parametric statistics and effect sizes were calculated for learning outcomes.

## Results

The teaching interventions resulted in large learning outcomes for both groups. Effect sizes were larger for the practical tests (Cohens  $d$  between 1.93 and 3.62) compared to the theoretical tests (Cohen's  $d$  between 1.03 and 1.29). Students taught by fellow students scored significantly higher, mean 65.5 (SD 12.9), compared to the group taught by associate professors, mean 35.0 (SD 23.3),  $p < 0.0001$ . There were no significant differences between the learning outcome in the practical test on IV access or in the theoretical tests. However, there were significant differences between participants' reactions to the teaching, where the student teachers scored higher on elements relating to the level of attention they paid to participants' different levels of prior knowledge ( $P = 0.045$ ). Further, the participants' understanding of the complications related to the procedure was rated higher in the group taught by student teachers ( $P = 0.033$ ).

## Limitations

This study was limited by being an experimental single-center study, in which only two procedures were assessed. Both procedures were simple clinical skills and it is not known whether the result generalize to complex skills. Further, only the effects on participants' learning outcome were assessed and other potential factors, such as reciprocal learning and the effects of power relations, were not addressed in this study.

## Conclusion

This study indicates that professional student teachers are just as good as associate professors in teaching procedural skills.

## CONSTRUCT VALIDITY OF THE REPORTER-INTERPRETER-MANAGER-EDUCATOR STRUCTURE FOR ASSESSING STUDENTS' PATIENT ENCOUNTER SKILLS [79]

### Background

A new paradigm of competency-based education has brought attention to development and validation of instruments for assessment of clinical competence. In 1999, Pangaro designed a new framework – the Reporter-Interpreter-Manager-Educator framework - for in-training evaluation of students from novices to competent practitioners [1]. The framework has gained widespread popularity, which may be due to the relative ease with which it relates to taxonomies for learning [44] and development of expertise [43]. Whereas there is some evidence of concurrent validity of the RIME framework [47], construct validity has not been assessed for single-patient encounters.

The aim of this study was therefore to assess construct validity of the RIME framework for single-patient encounters and to evaluate the use and reliability of the scores obtained, when put into use by clinician examiners for end-of-clerkship exams.

### Methods

A structured scoring form was constructed based on the RIME framework. Five-point Likert-scales were used for items in each of the four RIME categories. An experimental study was used to assess construct validity of the RIME framework and an observational study was used to assess the use and reliability of the RIME framework for oral examinations of students' patient encounter skills.

In the experimental study, three groups of participants consisting of 16 fourth-year medical students, 16 sixth-year medical students and 16 postgraduate year 1 interns, were included. All participants were instructed to manage two patient encounters – one in internal medicine and one in general surgery. The encounters were directly assessed by one of four associate professors, who rated the performances using the RIME framework. Video-recordings of the performances were performed to allow subsequent assessment by a second associate professor. Scores were compared between groups, effect sizes were calculated, and inter-rater reliability between raters was assessed.

In the observational study, RIME-based end-of-clerkship oral examinations of three consecutive cohorts of fourth-year (N=677) medical students were assessed. All students managed one patient encounter, which was rated by two clinician examiners. The distribution of scores across the three cohorts was analyzed and inter-rater reliability was assessed using intra-class correlation coefficients (ICC).

### Results

The experimental study showed statistically significant differences between RIME scores from the three groups of participants; mean 41.7 (SD 11.0) for fourth-year students, 48.2 (SD 10.9) for the sixth-year students, and 61.9 (SD 8.5) for the interns,  $P < 0.0001$ . Post-hoc analysis showed statistically significant differences between fourth-year students and interns ( $P < 0.001$ ) and between fourth-year students and sixth-year students ( $P < 0.001$ ) but not between sixth-year students and interns ( $P = 0.24$ ). Fur-

ther, participants progressed through the RIME framework with increasing experience. The inter-rater reliability was  $ICC = 0.53$ . In the observational study, the RIME scores were higher, mean 83.8 (15.5), and elements relating to Manager and Educator items were frequently missing.

### Limitations

This study was limited by the relatively small sample size in the experimental study but consistently displayed high reliability scores when used for end-of-clerkship assessments. The many missing RIME items suggested lack of support from the clinical examiners, which was a limitation to the observational study but also an important result. Further, the large case-to-case variability suggested that broad sampling across a larger number of cases is needed for reliable assessments.

### Conclusions

This study demonstrates that the RIME structure possess construct validity in terms of reflecting increasing levels of competence in managing patient encounters. However, the many missing values in the observational study indicated that clinician examiners may tacitly score elements according to what is expected of student at a certain academic level.

## IMPROVING EFFICIENCY OF CLINICAL SKILLS TRAINING: A RANDOMIZED TRIAL. [80]

### Background

The search for optimized training methods has been a recurrent subject of medical education literature. The rising number of medical students and the impact this has on learning has been a subject of concern in recent medical education literature [14,16]. The search for effective training protocols involves the concept of collaborative learning. Literature from outside the medical domain suggests that training in pairs may yield the same learning outcome despite half the amount of hands-on training compared to training alone. However, this concept has not been explored within the domain of medicine. The aim of this study was therefore to assess the effects of dyad practice compared to training alone on the subsequent management of patient encounters.

### Methods

This study was an experimental, randomized, observer-blinded trial. Forty-nine pre-clerkship medical students with no prior clinical experience underwent a four-hour course on how to manage patient encounters. The students were then randomized to either dyad practice or to training alone. In the subsequent four-hour training session, all students were instructed to manage four simulated patient encounters. The dyad participants were instructed to shift turns as the active participants, whereas the single group participants were instructed to manage all four patient encounters alone. Hence, the dyad group received half the hands-on time as the participants training alone. All students evaluated their confidence in managing future patient encounters after completing the training. Two week later, a performance test including two patient encounters was used to assess students' patient management skills. This time, however, all students managed the patient encounters individually. Video-recordings were performed to allow subsequent assessment by two blinded raters using the Reporter-Manager-Educator-Manager framework. RIME-scores were compared between groups for differences and inter-rater reliability was assessed.

## Results

The dyad group outperformed the single group in the retention test; mean 40.7% (SD 6.6) versus mean 36.9%,  $P=0.04$ , effect size 0.61. The inter-rater reliability was  $ICC=0.69$ . Further, the dyad group was significantly more confident in managing future encounters compared to the single group; mean 7.6 (SD 0.9) versus 6.5 (SD 1.1),  $P<0.001$ , effect size 1.16.

## Limitations

The current study was limited by the relatively small sample size as well as by its experimental nature. Future studies are needed to assess if the beneficial effects observed in this study extends to more competent students as well as exploring if and how this type of skills training can be implemented in clerkships and skills labs.

## Conclusions

Clinical training in pairs is more effective and efficient than training alone and it has positive effects on students' confidence in managing the patient encounter.

## FEASIBILITY OF SELF-DIRECTED LEARNING IN CLERKSHIPS [81]

### Background

Self-directed learning is a subject that has received considerable attention in the medical education literature over the past decades. However, there are few studies exploring the effectiveness of self-directed learning in clinical settings. In small and controlled settings, the use of self-directed learning initiatives has been shown to promote increased student participation in clerkships [69] and to improve the diagnostic reasoning skills in ambulatory settings [82]. However, there is little evidence of the effectiveness of self-directed initiatives in larger and more dispersed settings. The aim of this study was therefore to examine how students use self-directed Clinical Encounter Cards (CECs) to assess the usefulness of self-directed initiatives in in core clerkship.

### Methods

This mixed-methods study consisted of three steps. In the first step, a critical literature review informed the design of a self-directed CEC. This was trialed in a pilot group consisting of 12 year-four medical students, who provided user comments, and four medical experts provided comments to inform the final format of the self-directed CECs. In the second step of the study, the self-directed CECs were introduced in two pilot focus groups of eight year-four and 11 year-five students, who were asked to complete 10 CECs during a four-week trial period. The students were then interviewed regarding the use and feasibility of the CECs as well as how it affected their learning, participatory practice, and reflection on practice. In the third and final step, the CECs were implemented in two cohorts of medical students ( $N=498$ ) in core clerkships. At the end-of-clerkship evaluations, they were surveyed about the usefulness and feasibility of the self-directed CECs.

### Results

The pilot groups reported positive effects of the CECs in terms of engaging in diagnostic reasoning, reflection on management plans, and professional identity formation. However, the two cohorts of medical students rated the usefulness of the CECs on learning in clerkships very low (year-four: mean 2.92, SD 1.54; year-five: mean 2.28, SD 1.06) using nine-point scales where 1 is not useful at all and 9 is extremely useful. Preceptor support was

rated accordingly low (year-four: mean 2.68, SD 1.62; year-five: mean 2.59, SD 1.78).

### Limitations

This study was limited by the response format as students only reported perceived levels of participatory practice, diagnostic reasoning, and reflective practice and no objective measures assessed these factors. However, the aim of this study was not to assess the relative impact of the CECs on actual performances but rather to explore the usefulness and feasibility of self-directed measures as a concept in large and dispersed settings.

### Conclusions

Self-directed CECs can have positive effects on participatory practice and clinical reasoning when implemented in a supporting environment but the chance of success depends on the context of use. Self-directed CECs can be successful but major faculty development initiatives are required before implementation in large and dispersed settings.

## SUMMARY AND DISCUSSION

In this section, each research question will be addressed individually and the overall research question will be discussed at the end. Limitations and implications of the studies as well as topics for further research are finally discussed.

*Research question 1: "How do student teachers compare to clinical associate professors regarding the quality of procedural skills' teaching in terms of participants' technical skills, theoretical knowledge, and satisfaction with the teaching?"*

The first study of this thesis established that procedural skills teaching can just as well be delivered by student-teachers as associate professors, which has later on been confirmed by a considerable number of research articles on peer-assisted learning [83-93].

The student teachers used in this study were professional teachers employed by the skills center and teaching on a regular basis. This contrasts existing literature on peer-assisted learning carried out in other countries, where the teaching activities are usually based on voluntary participation of learners as well as of the student teachers [34, 94,95]. However, the underlying theory on peer-teaching and -learning is the same. The advantage of peer-teaching is assumed to rely on students' closeness in their zones of proximal development and acquisition of competence [40,43]. There is now good evidence that student teachers deliver high-quality teaching comparable to that provided by experienced clinicians when teaching technical clinical skills [85,88]. Further, student teachers may tacitly apply pedagogical strategies that are considered desirable by their peers, as suggested by learners' evaluations in our study. A recent study showed contrasting results indicating that students rated doctors higher on items relating to 'fun' and 'competency', which the authors explain by the lack of pedagogical training of the student teachers and the presence of extensive didactic experience of the doctors [88]. This discussion may in turn be of little relevance as both studies conclude that the 'professional' teachers – that being student teachers or doctors – are preferred by students, indicating that the pedagogical skills does relate to competency but not necessarily to clinical experience when teaching basic clinical skills. However, the teaching provided by student teachers may in some cases be inferior to that provided by experienced clinicians if

competence in the subject matter depends heavily on clinical experience [96].

*Study 2. The research questions were “Do assessment scores on the four RIME elements progress according to students’ increasing clinical experience?” and “How do clinician examiners in surgery and internal medicine use a RIME-structured scoring form in the oral examination of students’ patient encounter skills, and what is the inter-rater reliability of the scorings?”*

This study demonstrated construct validity of the RIME framework for assessing patient encounter skills. In the experimental part of the study, the three groups showed increasing total RIME scores. Moreover, participants progressed through the RIME framework as previously anticipated in the literature [1, 45, 46]. When implemented as framework for end-of-clerkship oral exams, the large amount of missing values and ‘Not Applicable’ denoted the items regarding psycho-social, ethical, and learning issues raised questions regarding the feasibility and acceptability of the concept. The results may also suggest that preceptors assess students according to what may be expected from them. Finally, it has been proposed that very elaborate and detailed rating forms disrupt the pattern-recognition processes used by expert examiners [97], which may cause elements considered of lesser importance to be ignored by assessors. In conclusion, the RIME framework is reliable and discriminates between different levels of performance when assessed according to an advanced criterion and is thus an appropriate instrument for assessing patient encounter skills in future studies. However, this study showed that students receive low scores in items relating to the role as Interpreter, Manager, and Educator. Consequently, there is a need to stimulate these aspects of student performance beyond basic clinical skills training facilitated by peer students as described in the first study of this thesis.

*Study 3. The research questions were: “What effect does dyad training of junior medical students have compared to single training, assessed by a performance test of patient management skills two weeks after the training?” and “What is the students’ perception of the training format in terms of confidence in managing future clinical patient encounters and perceived advantages or disadvantages of dyad training?”*

This study demonstrated that dyad training is superior to single training of patient encounter skills in a controlled setting. Participants in the dyad group achieved significantly higher RIME-scores than those in the single group. Further, the dyad group rated confidence in managing the patient encounter significantly higher than the single group. Although the study sample is small, this study is the first to provide evidence that dyad practice does provide an advantage in clinical skills training. Whereas previous studies have mainly focused on complex psycho-motor skills [52,53,55], this study explored the effect of dyad training on a complex mix of skills needed to manage the patient encounter, which comprised knowledge, technical skills, communication skills, and reflective practice. Thus, training in pairs stimulated students to perform better on elements of the RIME framework compared to the scores of students in the previous construct validity study. This relates well to the theoretical framework for peer-learning suggested in previous literature [98], in which the joint construction of a shared understanding between helper and helped are continuously re-adjusted to improve learning for both

parties. This also corresponds well to the results from the first study, in which we anticipated student teachers to possess tacit pedagogical skills due to closeness in their zones of proximal development.

*Study 4. The research question was: “How do year-four and year-five medical students perceive the feasibility and usefulness of a self-directed Clinical Encounter-Card in core clinical clerkships?”*

The aim of this study was to explore the feasibility and usefulness of CECs as a self-directed concept leaving the initiative to the students in core clerkships. Results from focus groups indicated that using the CECs had the intended effects on students’ learning in terms of increased focus on differential diagnoses, management plans and follow-up, which made the students feel more like doing a doctors work. However, despite broad faculty enthusiasm and endorsement of the CECs, their use as a self-directed initiative failed to produce the desired effects when introduced in large numbers in core clinical clerkships. The absence of the desired effects may be attributed the clinical and educational contexts in which initiatives are used and the degree of students’ self-directedness included in the initiatives. Studies demonstrating beneficial effects of student-driven initiatives seem to have a limited number of preceptors and students [69,70] or take place in settings with close student-preceptor inter-action, i.e. out-patient clinics or general practice [82]. Moreover, successful implementation seems to rely on careful preparation of dedicated preceptors supporting the student-directed learning [15,82]. Situated learning theory and the concept of communities of practice [99,100] are conceptualizations used to explain the findings in our study, suggesting that students are left out of the community of clinical practice and the community of educational practice. Hence, student-centered initiatives do not leave learners closer to participatory practice or accelerate their acquisition of clinical skills as long as the communities of practices are not supportive. Our results and other studies [15, 71, 72, 77] indicate that the concept of participation in communities of practice relates better to small and controlled settings than large and dispersed setting, in which self-directed learning has yet to prove useful. In this study, the students were not stimulated by the self-directed encounter-cards, which may in part be explained by educational traditions in terms of absence of PBL, team-based learning or any other student-driven activities within our University. Although self-directed learning initiative possessed the ability to induce the desired effects, motivational factors for using the concept were lacking. The positive effects of peer-learning activities in the previous studies were all demonstrated in an experimental setting with highly motivated students. Hence, motivational factors must be considered to improve the use of student teachers, dyad training, and self-directed encounter cards in a clinical setting. One method to improve students’ motivation may be assessment of skills on an individual as well as on group level, which in previous studies has been demonstrated to improve students’ perception of responsibility for learning [60]. The role of assessment is a powerful drive for learning [101] and this may contribute to implement student-centered initiatives into clinical practice.

## CONCLUSION

The main research question was: “How can a student-centered approach contribute to clinical skills learning in undergraduate medical education – in the skills lab and the clinical clerkship?”

Clinical skills training in undergraduate medical education using a student-centered approach includes concepts of peer-teaching, dyad learning, and self-directed learning. These concepts focus on how to stimulate students' intrinsic pedagogical and cognitive capacities for teaching and learning clinical skills. This may be achieved with varying degrees of success depending on the context delivery of the intervention. Hence, studies involving peer-teaching and dyad training in a skills lab setting demonstrated increased effective training of basic as well as complex clinical skills. Dyad practice (or collaborative learning) positions itself close to peer-assisted learning although the mechanisms of action are different. The effects of dyad practice are obtained through observation of actions performed by peers in a mutually interdependent relationship whereas peer-teaching assumes that knowledge and skills are passed on vertically from a more able teacher to the learner. However, when a student-centered initiative was introduced in clinical clerkships, problems regarding lack of preceptor involvement interrupted the intended effects of the concept. Thus, concepts based on student interaction or self-direction may relate better to small and controlled settings than large and dispersed setting. Consequently, motivational instruments – such as in-training assessment – should be considered when implementing student-driven interventions in clinical settings.

In conclusion, student-centered initiatives can play an essential role in undergraduate clinical skills training. However, certain factors relating to the feasibility of student-centered skills training must be considered. This includes the setting (skills lab versus clerkships) and motivational factors of preceptors and students.

#### LIMITATIONS

There are certain limitations to the studies comprising this thesis. The internal validity of the studies considers the trustworthiness of the results produced in each study. The assessment instruments used in the student-teacher experiment pose a limitation as this underwent content and concurrent validation and it was not subject to the same rigorous validation procedure as subsequent RIME validation study. Similarly, the RIME framework proved to possess construct validity in a specific setting using a selected group of participants and assessors, which does not mean that it similar results will be found under different circumstances

The external validity of the results considers issues of generalizability to other settings. This regards the controlled studies as well as the clinical studies, although the controlled studies may be easier to reproduce in other settings. The studies conducted in the skills lab are not easily generalized to a clinical setting. The first study aimed at exploring the use of student teachers in their natural setting, i.e. the skills lab, which does not pose any particular problems regarding generalizability. Dyad training may be applicable in a controlled setting but may also be desirable in clerkships. The results from the dyad study are, however, not guaranteed to translate to a clinical setting. Although learning outcome was greatly improved along with confidence in managing the patient encounter, student may not stick to dyad practice in a clinical setting if they are afraid of missing important learning opportunities while observing their partner.

The use of the RIME framework for end-of-clerkship assessment purposes as well as a student-driven patient encounter card may well depend on the educational tradition specific to the country of use. Thus, in countries where students are evaluated on their

presentations skills in clerkship along with continuing in-training assessment of skills, the students may be more motivated to use self-directed encounter cards. The lack of preceptor-support and in-training evaluation characterizing clerkships within our institution may leave the students inherently self-directed in the first place and the encounter cards may thereby just be considered an extra, unnecessary workload.

#### IMPLICATIONS AND FUTURE RESEARCH

The implications of our study and other studies on peer-assisted learning indicate that students possess competence in teaching, as opposed to what has previously been suggested in the literature [39]. Larger studies are needed to establish effectiveness and efficiency of the teaching provided by student teachers including how this relates to costs of training. Little is known about how the interaction and meta-cognition in peer teaching is shaped between learner and teacher and further elaboration is needed of the theoretical models that have been used to explain peer-teaching [98]. Contemporary terminology on peer learning describes an interaction between the helper and the helped [31]. This terminology suggests a challenge regarding power relations between student and student teacher. However, the impact of this interaction on peer-teaching is a subject for future research as it may modify teachers' and learners' behaviors in both positive and negative ways. Whether the positive effects of near-peer teaching extend to situations where learners at higher levels are taught is not fully explored. Accordingly, the effects of clinically junior students teaching senior students or doctors in selected skills are subject for further research. In turn, this leads back to the theoretical models explaining the interaction during peer-teaching, as the cognitive partnership characterizing peer-teaching may become weaker when peers are separated by age, power-relations, and learning objectives. Thus, a learning curve as a function of distances in experience from teacher to learners may provide valuable insight into how to optimize peer-teaching, which is another topic for future research. As indicated in the discussion, the use of student teachers is different between countries although this distinction is not always clear in peer-teaching literature. Further studies are therefore needed on how to train and select future student teachers.

The study on construct validity of the RIME framework for assessing patient encounter skills provides empirical evidence to support the theoretical anticipations of the RIME framework and thereby related theories of development of expertise [43] and taxonomies for learning [44]. An interesting focus for further research is to explore the how larger groups of clinician assessors can be trained to perform criterion-referenced assessment if this is feasible at all. This may be pursued by observing clinicians during assessment of students to explore the cognitive processes of assessment and how this affects the use of assessment instruments.

The dyad study suggested that training in pairs is twice as effective as training alone in subject of medical skills training. The possible implications of dyad practice are tremendous to clinical skills learning in skills labs and clinical clerkship when faced with an increasing number of medical students and limited clinical teacher resources [14-16]. However, larger studies are needed to demonstrate that this effect extends to cohorts of students training in skills labs or clinical clerkships. As pointed out above, the concept may encounter problems regarding acceptability if im-

plemented to large-scale settings such as core clerkships. This is a subject for further research along with an exploration of the conditions that make dyad practice effective (social context, student interaction, content of training etc).

The final study of this thesis focused on how to use a student-centered self-directed concept for clinical skills training in core clerkships. Existing literature including our own study on self-directed learning in clerkship focus on student evaluations, end-of-clerkship grades, and number of completed encounter cards. Thus, further research in terms of observing students during performance and participation in clerkships is needed to develop a more detailed theoretical model for self-directed learning in clerkship. When implementing self-directed learning initiatives in clerkships, different factors relating to preceptors' and learners' motivation should be explored. The role of assessment on an individual and/or group level may play an important role and should be considered for future research. In previous studies [60], assessment has proven to promote students' experience of responsibility for their own learning and similar results may apply to how self-directed learning is received in a clinical setting. In this thesis, the impact of educational tradition on the use and feasibility of self-directed learning in clerkships has been discussed. Consequently, attention should be paid to factors relating to the educational environment in order to determine whether an intervention becomes a success or not. Future studies should therefore focus on examining characteristics of different organizations and clerkship sites, as this may be a better predictor of successful educational outcome than comparing different instructional methods.

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#### SUMMARY

This thesis focuses on how to engage students in self-directed learning and in peer-learning activities to improve clinical skills training in undergraduate medical education. The first study examined the clinical skills teaching provided by student teachers compared to that provided by associate professors. This study showed that student teachers performed as good as or even

better than associate professors when teaching simple clinical skills. The second study of this thesis examined how complex clinical skills – such as patient management skills – develop with increasing levels of competence. The Reporter-Interpreter-Manager-Educator framework was used to reflect this change and construct validity was explored for RIME-based evaluations of single-patient encounters. In the third study the effects of training in pairs – also known as dyad practice – were examined. This study showed that the students practicing in pairs significantly out-performed those training alone using RIME-based assessments and that dyad training significantly improved students' confidence in managing future patient encounters. The final study examined students' use of self-directed clinical encounter cards (CECs) based on the RIME framework. Results from this study showed that self-directed CECs can have positive effects on participatory practice and clinical reasoning when implemented in a supporting environment but the chance of success depends on the context of use. Self-directed CECs can be successful but major faculty development initiatives are required before implementation in large and dispersed settings. In conclusion, this thesis demonstrated different aspects of student-centered approaches to clinical skills learning. Whereas self-directed learning is difficult in clinical clerkship, the experimental studies demonstrated remarkable advantages to peer-learning in skills-lab. Thus, peer-learning activities could be essential to providing high-quality medical training in the face of limited clinical teacher resources in future undergraduate medical education.

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