

## EDUCATION

# Interprofessional approach for teaching functional knee joint anatomy<sup>☆</sup>



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## ABSTRACT

Profound knowledge in functional and clinical anatomy is a prerequisite for efficient diagnosis in medical practice. However, anatomy teaching does not always consider functional and clinical aspects. Here we introduce a new interprofessional approach to effectively teach the anatomy of the knee joint. The presented teaching approach involves anatomists, orthopaedists and physical therapists to teach anatomy of the knee joint in small groups under functional and clinical aspects. The knee joint courses were implemented during early stages of the medical curriculum and medical students were grouped with students of physical therapy to sensitize students to the importance of interprofessional work. Evaluation results clearly demonstrate that medical students and physical therapy students appreciated this teaching approach. First evaluations of following curricular anatomy exams suggest a benefit of course participants in knee-related multiple choice questions. Together, the interprofessional approach presented here proves to be a suitable approach to teach functional and clinical anatomy of the knee joint and further trains interprofessional work between prospective physicians and physical therapists as a basis for successful healthcare management.

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## 1. Introduction

Profound knowledge of functional anatomy is essential for physicians and clinicians. Especially surgeons and orthopedists are required to have a deep understanding of functional human anatomy and the respective anatomical structures. Next to topographic anatomy needed for radiology and surgery, orthopedists must understand the functional principles of human anatomy for clinical examination and comprehend the pathomechanisms underlying traumatic injury and diseases. Furthermore, the increasing use of medical imaging technologies defines excellent anatomical knowledge as a prerequisite for correct interpretation of imaging reports. Gross anatomy courses using cadavers are com-

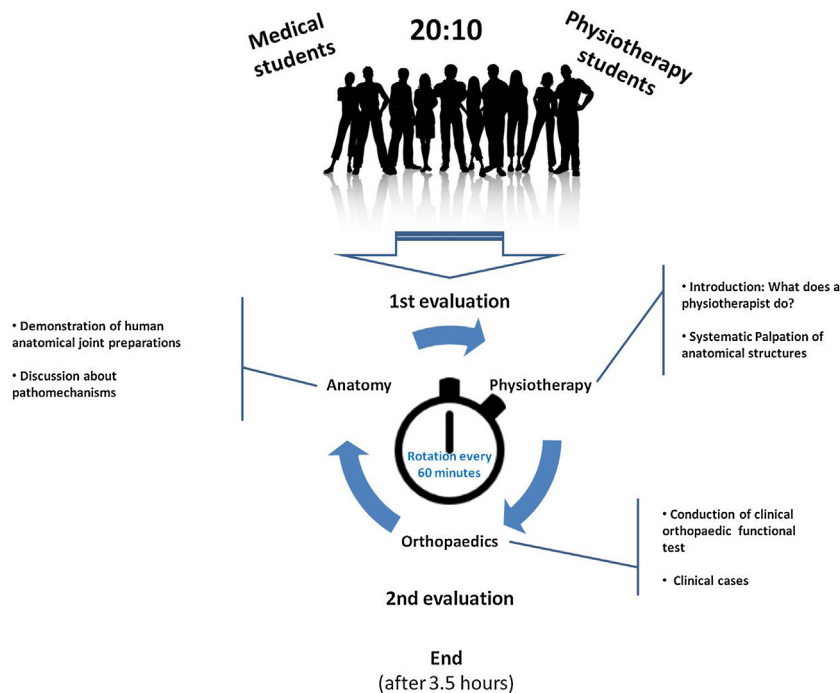
monly used to teach anatomy and recent reports have underlined the importance of these courses as reflected by students (Böckers et al., 2010) as well as professional surgeons (Older, 2004).

However, in the current medical school curriculum of the University of Freiburg, human anatomy is taught in preclinical courses during the first two years of basic medical education, whereas orthopedic examination courses are placed at later time points of the clinical part of the medical curriculum. Although both topics are educationally closely related, they are taught independently of one other. Interestingly, several studies have shown that preservation of anatomical knowledge from the beginning of the medical education to later clinical phases is meager (Feigin et al., 2007; Prince et al., 2005). These observations correlate well with the fact that many advanced students and recent graduates feel insufficiently prepared in anatomy for practical clinical tasks (Bohl and Gest, 2011; Gogalniceanu et al., 2010). In addition to the long period of time between gross anatomy courses and clinical applications and examinations, the lack of applied and functional teaching of anatomical knowledge from the beginning of medical education

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**Fig. 1.** Schematic overview of the interprofessional course design.

is likely to be a relevant factor. As the modern healthcare system shifts toward interdisciplinary and interprofessional care, medical education – including anatomy teaching – should take these developments into consideration by modifying the current curricula. The benefits of team-based (Nieder et al., 2005; Huitt et al., 2015) as well as problem-based (Wang et al., 2010) anatomy teaching have recently been described. Moreover, interprofessional collaborations are of outstanding importance for clinical healthcare and especially effective interactions between orthopedics and physical therapy secures the success of a surgical intervention during post-treatment (Shoji et al., 1990). However, this component of interprofessional clinical work in cooperation with different professions falls short in medical education, but is of major importance for the future health care system (Kirch and Ast, 2015).

Here we introduce a new interprofessional approach for effectively teaching anatomy of the knee joint which includes the above-mentioned points. The presented teaching approach involves anatomists, orthopedists and physical therapists to teach functional and clinical anatomy of the knee joint in small groups. The courses were implemented at early stages of the medical curriculum and medical students were grouped with students of physical therapy to sensitize students to the importance of interprofessional work. Evaluation results clearly demonstrate that medical students and physical therapy students appreciated this teaching approach and first evaluations of anatomy exams suggest a benefit to course participants in knee-related multiple choice questions. Together, the interprofessional approach presented in this study might be a suitable approach for teaching functional and clinical anatomy and further training interprofessional work between prospective physicians and physical therapists.

## 2. Material and methods

### 2.1. Course participants

Each teaching course was designed for 30 participants (20 medical and 10 physiotherapy students) per day. Lists for enrolment were available at the beginning of the anatomic preparation course.

As the demand for participation was greater than the supply, additional students were accepted in exceptional instances. From 2012 to 2015, 230 individuals participated in the course; of these 56 were physiotherapy students.

### 2.2. Anatomical preparations of knee joints

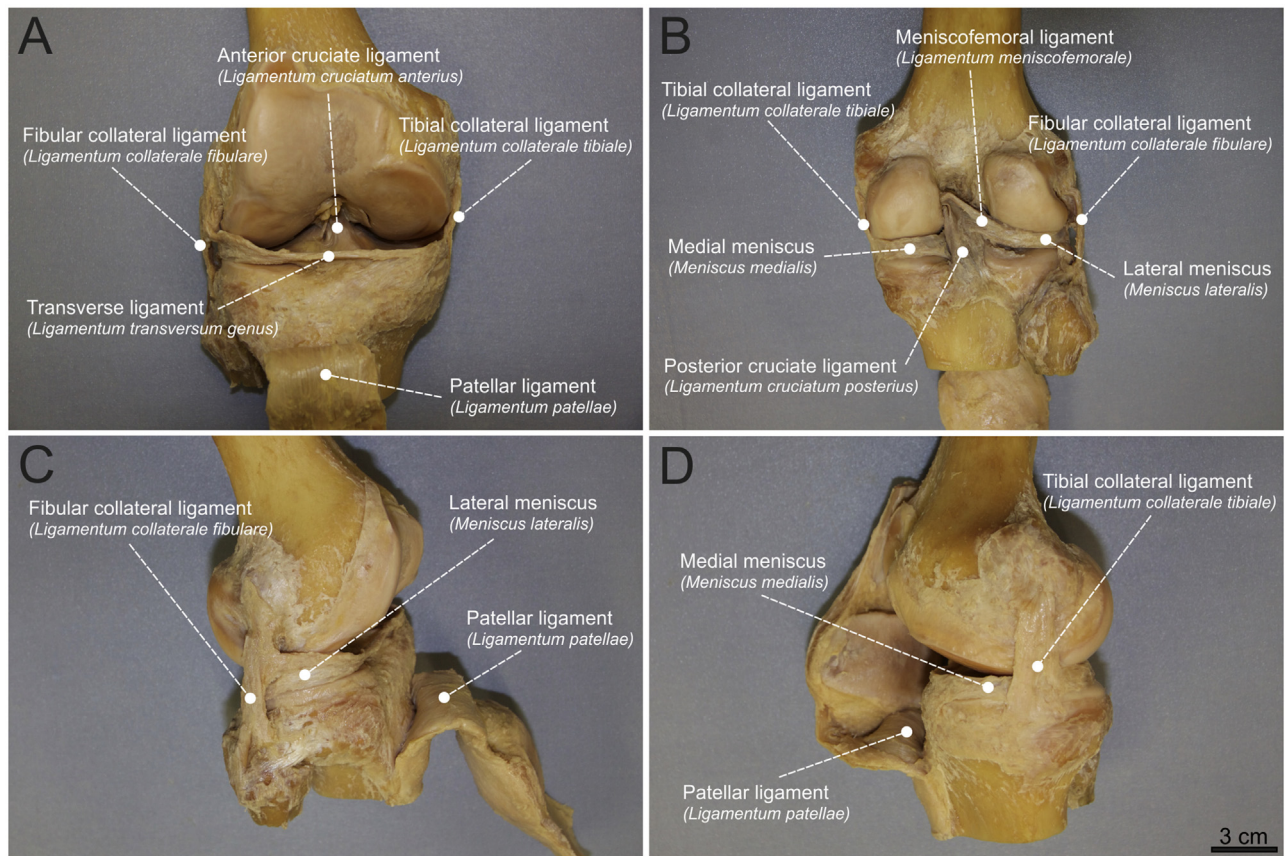
Preparations of knee joints and the respective knee ligaments including menisci were used from body donors from the Institute of Anatomy and Cell Biology of the Albert-Ludwigs-University Freiburg. Joint specimens were used according to the intended use of the body donation agreements. Images were taken using a Canon EOS 500D (Canon Deutschland GmbH) and figure panels were designed, processed and labeled using CorelDRAW X5 graphic software (Corel Corporation).

### 2.3. Evaluation

The evaluation was conducted at the beginning and at the end of every course. Standardized questionnaires were designed using items of the Heidelberger Inventory (HILVE-I/II) (Rindermann and Amelang, 1994). Briefly, multidimensional questionnaires were designed and used for the assessment of teaching quality and teaching by students and teachers and further considered aspects such as motivation and potential benefits for participants. Additionally, the number of correct answers concerning the “knee” in the anatomical exam of participants ( $n = 108$ ) was compared with those of non-participants ( $n = 207$ ). The anatomical exam contained two questions specifically on the anatomy of the “knee”. Programs used for evaluation data analysis were Microsoft Excel and SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.).

### 2.4. Statistics

Data are presented as means  $\pm$  standard error of the mean (SEM). Diagrams and all statistical analyzes were generated and performed using GraphPad Prism5 software (GraphPad Software Inc.).



**Fig. 2.** Anatomical knee joint preparations. Examples of knee joint preparation used throughout the course to demonstrate ligaments of the knee under functional aspects. Ventral (A), dorsal (B), lateral (C) and medial (D) views are depicted. Scale indicates 3 cm.

### 3. Results

#### 3.1. Course design and schedule

The educational concept of the course was based on the idea of bringing students and lecturers of different medical disciplines together in order to learn from, about and with each other. At this point we want to emphasize that initiation of this course, evaluation and fund raising was done by medical students. As participation was elective and increasing curriculum loads should be avoided, the course has been designed in the following way: an interprofessional team constituted of a lecturer for anatomy, an orthopedic surgeon and a physical therapist presented different aspects of the knee joint from their respective different professional perspectives. These different perspectives were intended to help students to develop a better understanding of the relevant questions concerning knee joint examinations and pathogenic mechanisms of traumatic and degenerative processes. Furthermore, the supervisors gave the participants an impression of different methods of approach to the same anatomical structure.

For each course, 30 participants (20 medical students and ten physical therapy students) were accepted.

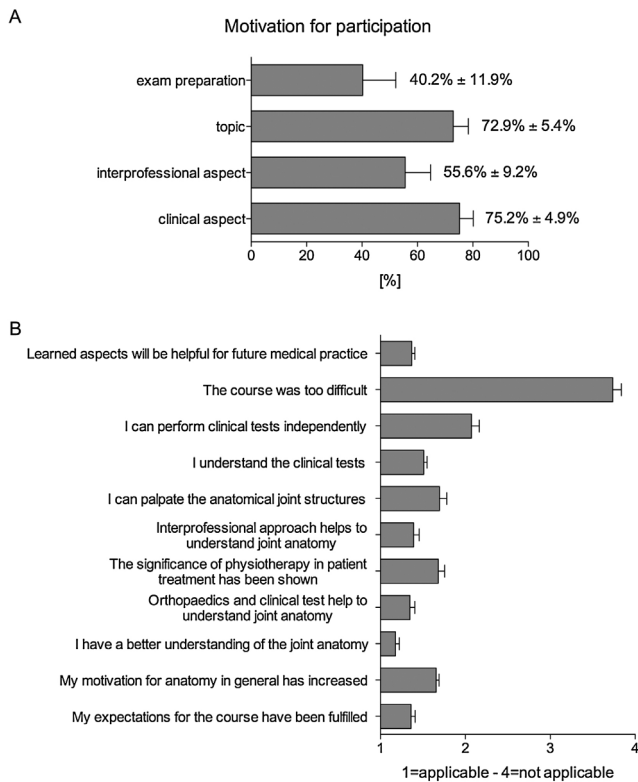
Fig. 1 gives an overview of the general course design and schedule. Beginning with a short introduction to the general course idea and the workflow of the course, groups of ten persons (two-thirds medical students and one-third physical therapy students) started at the different stations of anatomy, physical therapy or orthopedics. After 60 min, groups switched their stations taking a total time of about three hours for the entire knee joint course.

In order to demonstrate anatomical structures in the most realistic manner, knee joint preparations including menisci and

ligaments were prepared from human cadavers in advance by a trained anatomical prosector (Fig. 2). After distribution of the joint preparations to the students (at least one per two students) anatomical and clinical relevant biomechanical principles of the knee joint function were presented and discussed at the anatomy station. Moreover, the flexibility of the joint preparations allowed for demonstration of tension and relaxation of knee ligaments during flexion, extension and rotation and thus supported the teaching of functional knee joint anatomy. At the physiotherapy station, students formed interprofessional groups of two persons and were introduced to and supervised during the systematic localization and palpation of different anatomical structures of the knee. All structures were marked with skin markers and discussed with the supervisor. The station of orthopedics was devoted to teaching of how to functionally test anatomical structures of the knee joint, such as the collateral ligaments and the menisci in order to diagnose potential ligament and menisci injuries.

#### 3.2. Evaluation

The pre-course questionnaire assessed motivation of students for their participation in the elective course offering several reasons in a multiple-choice format. Participants were able to choose multiple answers. As shown in Fig. 3A, physiotherapy students and medical students specified that the clinical aspect ( $75.2\% \pm 4.9\%$ ) and the topic itself ( $72.9\% \pm 5.4\%$ ) were the most attractive reasons to participate in the knee joint course. More than half of all course participants were motivated by the interprofessional aspects ( $55.6\% \pm 9.2\%$ ). Interestingly, the least motivating aspect was the preparation for later anatomical exams ( $40.2\% \pm 11.9\%$ ).



**Fig. 3.** Results of pre-course evaluation for motivation of participants (A) and post-course evaluations (B). Multiple answers could be chosen in pre-course evaluations. Data are presented as means  $\pm$  SEM from four independent courses.

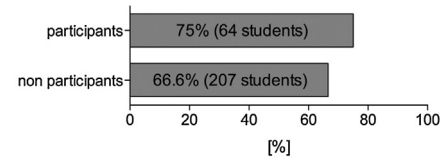
Other common points mentioned were the physical contact with anatomical preparations or special interest in sport injuries.

In the post-course questionnaire, participants were asked to rate different statements concerning the quality and usefulness of the knee joint course (Fig. 3B). The most relevant results from these post-course evaluations were that participants had a better understanding of the knee joint anatomy and that the general motivation in anatomy had increased after the course. Moreover, palpation and clinical testing helped to understand the joint anatomy. According to the evaluations, the interprofessional approach subjectively supported the understanding of knee joint anatomy. Together, these evaluations underline that medical students and physiotherapy students appreciated this interprofessional teaching approach for knee joint anatomy and were motivated to participate by the interprofessional aspect and the functional and clinical aspects of the course.

### 3.3. Evaluation of anatomy exam results

Although the participants felt that the course increased their understanding of knee joint anatomy, we analyzed whether medical students were better in answering knee joint-related questions in the written multiple-choice anatomy exam. Therefore, we compared the results of knee-joint questions of participants and non-participants. As shown in Fig. 4, 75% of the participants gave correct answers to these questions, whereas only 66.6% of the non-participants managed to find the correct answer. There was no significant difference between the two groups. Nevertheless, these preliminary results indicate that participants are better prepared for anatomy exams. However, more anatomy exams have to be evaluated in order to draw conclusions as to whether participants are better in correctly answering knee joint-specific questions.

### Written anatomy exam - knee joint-specific questions



**Fig. 4.** Percentages of correct answers to knee-specific multiple choice questions during the written anatomy exam given by participants and non-participants. Differences were not statistically significant.

## 4. Discussion

The data presented in this study shows that the interprofessional concept to teach knee joint anatomy was well received by students of both disciplines: medicine and physiotherapy. We observed that, over a period of four years, students gave similar feedback indicating a profound interest in and a need for additional, functional as well as clinical teaching approaches among students. Furthermore, we could show that anatomy of the musculoskeletal system, which is in general less appreciated and mastered – at least by medical students – becomes much more interesting to learn when connected to questions of practical relevance. We believe that this teaching approach contributes to a long lasting sensitization for orthopedic questions and a more profound understanding of functional anatomy. Anatomy test results suggested better performance in questions concerning the knee joint of students who had participated in the course. It seems to be self-evident that evaluation is biased by the fact that it is more likely to have been the more motivated students who would participate in an elective course. The fact that overall results of participants versus non-participants in the written anatomy exams did not show any significant differences (data not shown) demonstrates that this is not the case. Given that participation is optional, written anatomical tests to evaluate the benefit of participants due to the course did not seem to be appropriate for evaluation. As physiotherapist students do not have a written exam at the end of their anatomy studies, effects on the anatomical knowledge are difficult to measure within this group. First evaluations of knee-specific questions in written anatomy exams suggested that medical students who had participated were superior in correctly answering knee joint questions. However, the number of questions was very low and more groups have to be analyzed in order to draw any conclusions on the benefit of this teaching approach for later exams.

The interprofessional approach has been shown to be advantageous for an anatomical teaching concept in different ways: according to the evaluation results, especially from medical students, palpation and clinical tests helped to provide a better “feeling” for anatomical structures that are often neglected. Having students and supervisors of two professions together underlines the importance of the topics treated for health. Particularly medical students in their second year are not aware of the extent to which other health care professionals will cooperate with them at later clinical stages. Recently, the World Health Organization WHO (2010, World Health Organization – Framework for Action on Interprofessional Education & Collaborative Practice WHO/HRH/HPN/10.3), the German Council of Science and Humanities (Wissenschaftsrat, 2014, <http://www.wissenschaftsrat.de/download/archiv/4017-14.pdf>), Walkenhorst and Schäfer (2012) as well as the Advisory Council on the Assessment of Developments in the Health Care System (Sachverständigenrat zur Begutachtung der Entwicklung im Gesundheitswesen: Gutachten 2007: Kooperation und Verantwortung – Voraussetzungen einer zielorientierten Gesundheitsversorgung <http://www.svr-gesundheit.de/index.php?id=15>) have stated that interprofessional education and

research should be extended in order to provide a more integral medical approach taking advantage of synergistic effects bringing together different health care professions. This interprofessional course fulfills these requirements and is part of the Longitudinal Strand Interprofessionality (LongStI), which comprises 13 different interprofessional projects offered during medical studies. This consortium was created in 2013 by the Medical Faculty of Freiburg and aims to integrate different interprofessional workshops into the medical curriculum. From funds raised in the last three years it has been possible to acquire materials and produce long lasting anatomical preparations. During the next years, courses covering the topics “shoulder” and the “lumbar vertebral column” will be designed and offered according to the teaching approach presented in this study. With the existing equipment, continuity is secured for the following years, as no larger investments will be necessary.

## 5. Conclusions

In this study, we presented an interprofessional teaching concept for medical students and physiotherapy students that complement the existing medical curriculum at the University of Freiburg. Evaluation of these courses showed high acceptance and appreciation among participants of both professions and participation seemed to be associated with better anatomy exam results. We propose that this interprofessional teaching approach is a contemporary and appropriate method of teaching functional and clinical anatomy (Leveritt et al., 2016), strengthening interprofessional cooperation as an essential aspect of modern healthcare and further fulfilling the requirements for future adaptation of medical teaching and preclinical curricula as requested by the Wissenschaftsrat. Upcoming courses will be developed and implemented in the medical curriculum and sophisticated evaluations will be conducted in order to determine the benefit of interprofessional teaching in anatomy for anatomy exams and later clinical applications.

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