

## HOW WE TEACH | *Generalizable Education Research*

### Peer teaching beyond the formal medical curriculum

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**Engels D, Kraus E, Obirei B, Dethleffsen K.** Peer teaching beyond the formal medical curriculum. *Adv Physiol Educ* 42: 439–448, 2018; doi:10.1152/advan.00188.2017.—Peer-assisted learning (PAL) is nowadays commonly implemented in medical education. Mostly PAL is utilized to specifically support teaching within one subject or a specific curricular situation. Here, we present a large-scale peer teaching program that aims to address the individual student's learning needs. In addition, it provides a platform for students to participate in academic teaching. A retrospective data analysis was performed to reveal the program's development and acceptance. The program was implemented in 2008/09 with three tutorials conducted by 24 student tutors to support students preparing for reexaminations. Since then, the program has continuously grown. In 2015/16, 140 tutors conducted 52 tutorials, consisting of 2,750 lessons for 1,938 tutees. New tutorial categories were continuously introduced. In 2015/16, these encompassed tutorials that were held concomitantly to the formal curriculum, tutorials that exceeded the contents of the formal curriculum, tutorials for preparation for the state examination, and electives. Evaluations among the tutees revealed that 93.5% of the respondents rated the courses overall as “good” or “excellent” ( $n = 13,489$ ) in 2015/16. All elements of the peer teaching program are managed by one academic group. This encompasses the organization of tutorials, the quality management, and the qualification of tutors, including content-related supervision and didactic training. We conclude that the implementation of a large-scale peer teaching program can complement the formal curriculum. This might be beneficial for both tutors who can actively train their didactic and content-related competencies, and tutees who can autonomously consolidate and expand their knowledge.

educational measurement; medical education; peer-assisted learning; peer teaching; student teacher

#### INTRODUCTION

Peer-assisted learning (PAL) is defined as “the development of knowledge and skill through explicit active helping and supporting among status equals or matched companions, with the deliberate intent to help others with their learning goals” (48). There are numerous possibilities to integrate PAL into higher education. The best known are peer teaching, peer tutoring, and peer mentoring. Most of the published articles deal with the aspect of peer teaching (4, 48). Peer teaching can be defined as the educational constellation in which one student teaches another student or a group of fellow students (46). Ten Cate and Durning (47) have elaborated on three dimensions of peer teaching, namely the academic distance between student

teacher and learner, the group size, and the formality of teaching. They differentiate between reciprocal teaching, in which student tutor and tutee are at the same stage of training, and cross-level teaching, where the students' academic levels diverge. Both peer teachers and learners seem to benefit from the participation in peer teaching programs (42, 43, 50). Additionally, there is evidence that there are no significant differences between peer-led and faculty-led teaching of communication skills or clinical skills (39). Researchers hypothesize that the success of peer teaching is due to a cognitive and social congruence between peer teachers and tutees (19, 20, 30). Peer teachers, having not long ago dealt with the subject matter themselves, are more easily able to teach at a suitable level focusing on a basic understanding of concept (30). Thereby, they address problems they experienced themselves while studying the matter and offer solutions toward grasping different concepts.

Most medical faculties deploy peer teachers in skills laboratories (3). Further fields of action for peer teachers are the preparation for summative exams (7), diagnostic imaging PAL courses (22), gross anatomy dissection courses (17, 35), teaching clinical skills (3, 5, 49), problem-based learning (14, 25), communication skills (36, 37) or subject-specific tutorials (10, 24, 28, 41). To our knowledge, most published peer teaching programs focus on a specific curricular situation. An exception is the peer teaching program described by Sammarai et al. (41), which aims to fill curricular gaps in preclinical education.

In this study, we describe the implementation of a large-scale peer teaching program that offers tutorials in addition to the formal curriculum. Its development and acceptance were analyzed based on a retrospective study. We hypothesize that the implementation of a large-scale peer teaching program can be an approach to widen the academic teaching offer and complement the formal curriculum. Furthermore, this program might support students in their medical studies and provide a platform for student teachers to gain competencies in academic teaching.

With ~900 students who enroll each winter semester, the Ludwig Maximilians University (LMU) is one of the largest medical faculties in Germany (21). The medical curriculum at the LMU consists of two parts: a 2-yr preclinical and a 4-yr clinical part (6, 32). The preclinical studies mainly encompass anatomy, physiology, and biochemistry, as well as basic scientific subjects (chemistry, biology, and physics) and medical psychology (6). These subjects are taught by lectures for an auditorium of up to 900 students, as well as through seminars and practical courses with a group size of ~20 students. The clinical part includes courses in all clinical subjects, as well as a 1-yr practical training (6). Both the preclinical and clinical

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part of the medical curriculum are completed by a state examination. All students have to pass subject-specific examinations during their preclinical studies as a prerequisite for the admission to the first state examination. Each of these examinations may be repeated three times, if the former attempt failed (31). Recently, we showed that >30% of the students failed in at least one of their first attempts at an examination (42). The formal curriculum is very similar for each student, except for one preclinical and one clinical elective. In accordance with this uniformity, there are no curricular courses to support students who have failed at their first attempt at an examination with their preparations for reexaminations (31).

The initial aim of the peer teaching program was to provide a structured and quality-controlled support for these students and to improve their performance as well as to increase the success rate for reexaminations (42). Over the years, the program and its objectives have further developed, and new tutorials have been introduced based on the Kern cycle (27). Diverse courses following different objectives have been implemented over the years. Depending on the nature of the courses, their aims range from the support in the preparation for reexaminations, the improvement of success rates, and the structuring learning, to provide deeper insights into selected subjects or medical themes.

## METHODS

### Program Description

The peer teaching program is coordinated by one academic group composed of research associates from different disciplines (medicine, sciences, veterinary medicine, and pharmacy), as well as a secretary. In the following, the term “peer teaching platform” will be used to summarize the activities of this group. The responsibilities include the organization of peer teaching tutorials, the content-based and didactical supervision, as well as the qualification of tutors and quality assurance, including the evaluation of the courses.

Within the scope of this article, a tutorial is defined as a thematic cluster of topics. For example, the tutorial “Neurophysiology” subsumes seven topics (membrane potential and action potential, muscle

physiology, motor skill and reflexes, sensation I, sensation II, hearing and speaking, as well as functions of the central nerve system). To maintain a small group size, each topic is often conveyed in multiple repetitive courses. Every course within the peer teaching program is led by a student tutor who teaches fellow students, the tutees. The tutor conceives the course in close collaboration with the research associate of the peer teaching platform who is in charge of the respective tutorial.

Based on the content and the temporal relation of the tutorials to the formal curriculum, the tutorials can be assigned to five different tutorial categories (Table 1). The tutorials, which are organized for the preparation for reexaminations (REX), concomitantly to curricular courses (CON), or as a preparation for the first state examination (STE), aim to support the formal curriculum and thereby mainly cover subject-specific contents. In contrast, a fourth category is made up of tutorials whose contents exceed the formal curriculum (EXC). These encompass, for example, seminars about learning strategies and clinical excursions, which aim to bridging preclinical learning matters to clinical phenomena. The aforementioned four categories of tutorials are extracurricular and are offered additionally to curricular courses on a voluntary basis. They do not replace any curricular courses. The fifth category subsumes electives (ELE). The electives are part of the formal curriculum, but can be selected by students according to their individual interests. In contrast to the other tutorials, the participation in electives is compulsory.

In general, tutorials can be offered in various formats: seminars, lectures, or skills trainings. These formats vary in their didactic purpose and group size. Whereas seminars provide a framework for a group of up to 30 tutees, a lecture can reach up to 300 learners. The advantage of seminars is the possibility to raise questions easily and actively discuss contents or identify learning difficulties and interests. Lectures predominantly focus on an overview of the content and can provide the audience with a comprehensive insight into the contents or repeat the contents of the formal curriculum. In skills trainings, participants actively train technical, methodical, or rhetorical skills. Therefore, the group size is limited to 20 participants.

*REX: tutorials for reexamination preparation.* A curricular subject or topic is usually completed by an examination. Depending on the subject or topic, these can be written or oral examinations. Passing the examinations is necessary to obtain the performance record. If students fail at this examination, they have the possibility to take a

Table 1. *Tutorial categories*

Category	REX	CON	STE	EXC	ELE
Content	Subject-specific, mainly curricular	Subject-specific, mainly curricular	Subject-specific, mainly curricular	Interdisciplinary, exceeds curricular contents	Individual, various topics
Primary aims	Support preparation and understanding, highlight medical relevance, motivate, answer questions, prioritize content	Support preparation and understanding, highlight medical relevance, motivate, answer questions, prioritize content	Learning strategies, prioritize contents, simulate examination situations	Motivate, link different subjects, outlook to further studies, skills training, learning strategies	In-depth insight into a specific field of medicine, train individual skills
Scheduling	Between first and reexaminations	Before or accompanying curricular courses	Longitudinal	Individual	Individual
Formats	Interactive seminar	Interactive seminar or lecture	Interactive seminar or lecture	Interactive seminar, practical or skills training	Interactive seminar, practical or skills training
Participants per course	1–30	1–300	1–300	1–30	3–20
Academic progress of participant	Preclinical or clinical	Preclinical or clinical	Preclinical	Preclinical	Preclinical

CON, concomitant tutorials; ELE, electives; EXC, tutorials that exceed the formal curriculum; REX, tutorials for reexamination preparation; STE, tutorials for the preparation for the first state examination.

second examination (reexamination), which usually is scheduled several weeks after the first. However, there is no curricular course that supports the students with their preparation. REX tutorials address this particular situation. The contents are aligned to the contents of the formal curriculum. REX tutorials are scheduled before the reexamination and are held as seminars to maintain a group size of a maximum of 30 participants.

**CON: concomitant tutorials.** CON tutorials are aligned to the curricular courses and aim to prepare students for the curricular courses, support students during the courses, or offer a repetition of the learning matter taught in the formal curriculum. In contrast to REX tutorials, the CON tutorials focus on the facilitation of the understanding of the curricular content rather than preparing for the examination. Depending on the demand, the courses are held either as seminars or lectures.

**STE: tutorials for the state examination preparation.** The preclinical part of the medical studies is completed by a state examination. STE tutorials aim to revise the contents of anatomy, physiology, and biochemistry, which are relevant for the first state examination. Additionally, they include exam simulations. STE tutorials are offered longitudinally to enable students to prepare themselves for the state examination during their last preclinical semester. Like CON tutorials, they are offered as seminars or lectures.

**EXC: tutorials exceeding the content of the curriculum.** EXC tutorials aim to connect themes of the formal preclinical curriculum to the clinical curriculum or to provide insights into learning strategies and motivational theories. So-called clinical excursions are designed for students in their preclinical studies. They aim to connect basic scientific knowledge taught in the preclinical curriculum to signs and symptoms and diseases. In practice, a tutor, who is potentially supported by a physician and/or a patient, presents a disease and discusses its pathogenesis from basic science to the clinical presentation. A slightly altered version of the clinical excursions is offered for first-year students during the faculty's familiarization week (clinical excursion for freshmen). These courses aim to provide an outlook and sensitize for the impact of basic scientific knowledge on clinical medicine. Additionally, EXC tutorials comprise tutorials that highlight learning strategies and are designed to support students when transitioning from school to university or when preparing for their first state examination. EXC tutorials are held as seminars or skills trainings.

**ELE: electives.** In contrast to all other courses of the peer teaching program, ELE are part of the formal curriculum. Every student has to participate in one elective during his or her preclinical studies. Here students can choose between different courses with diverse topics. Within the peer teaching program, it is possible for student tutors showing outstanding teaching performance to design and lead electives. Depending on the topic, it can be held as a seminar and can optionally include skills trainings.

#### *Recruitment, Supervision, and Training of Tutors*

**Recruitment.** Usually students apply at the peer teaching platform for the position of a tutor by e-mail. Students may enter the program as tutors at any stage of their studies (except for their first preclinical semester). The applicants have to fulfill the following requirements: 1) successful completion of the curricular activity to which the tutorial is adapted; 2) general interest in the subject of the tutorial; 3) willingness to intensively prepare the tutorial; 4) high motivation to teach and explain; and 5) proof of evidence of all required accomplishments up to the time of the tutorial within the scope of their own studies (42). Applicants are asked to fill in a standardized form. This form includes questions addressing their prior teaching experience, an overall self-examination of their academic performance, as well as their motivation to teach, and questions to determine which subjects they aim to teach. In the subsequently conducted job interview, a shared decision is made by the research associate of the peer teaching platform and the applicants concerning which tutorial they could lead.

**Supervision and training.** Tutors usually plan and lead only one topic of a tutorial. Thus the seven topics of the neurophysiology tutorial mentioned above are conducted by at least seven tutors. Tutors may be active in the peer teaching program until they graduate. A considerable number of tutors are active more than once (9). Whenever tutors are repeatedly active, they can either redo a topic, choose to lead a new topic within the "old" tutorial, conduct a new topic within a different tutorial, or choose to lead a tutorial of another category. Tutors with outstanding content-related interests and didactic competencies have the possibility to design new concepts for clinical excursions or electives. Hence, the tutor cohort is heterogeneous regarding their individual previous teaching experience.

To qualify student tutors for their teaching responsibilities, we established a partly standardized tutor training program, which comprises a workplace-based training, an intensive training, and individual consultations (Table 2). The workplace-based training comprises 24 lessons and contains didactic and content-related elements. The didactic elements include lesson planning and didactic as well as rhetoric training. The content-related elements of the workplace-based training include a discussion of the concept and the content of the course, which have been independently planned by the tutor beforehand. A subsequent simulation of a tutorial and a feedback session address both content-related and didactic aspects. In addition, each training includes a research associate of the peer teaching platform sitting in on at least one class. An individual supervision with research associates is provided for tutors who are active more than once to further adapt and improve their course. Especially when tutors decide to design a "new" topic, the individual support covers content-related supervision as well. The research associate in charge of the workplace-based training and the individual consultation of a particular tutorial is familiar with the respective curricular content. The content-related knowledge of the tutors is evaluated by individual consultations with the tutors and the attendance of the tutorials by the research associates of the peer teaching platform who are experts in the field (42).

The voluntary intensive training, which covers an additional 20 lessons, amplifies didactic and rhetoric contents of the workplace-based training and includes topics like communication and presentation skills, teaching methods, as well as microteaching, reflexivity processes, handling of difficult situations, and coping with test anxiety (42). To obtain the advanced "TutorPlus" certificate, which represents the official university-wide tutor degree, 40 units of the tutor training program have to be accomplished.

#### *Realization of Tutorials*

As a first step in the transition from conception to implementation of a tutorial, a database query is performed to estimate the prerequisites to execute a tutorial. In the database, all data of past tutorials are stored. This includes, e.g., evaluation designs and results, needs examinations, group sizes, schedules of tutorials, dates, numbers of participants, tutors, durations, and tutorial formats. The data are used to design and schedule the tutorial with respect to tutees' and tutors' needs, content, curricular reference, as well as group size, room requirements, and technical tools. In addition, the schedule is adjusted to the tutor's and tutee's individual curricular schedule. If necessary, the tutorial is adapted to changes, e.g., of the formal curriculum or requirements of tutees. Tutors are recruited based on their prior performance and expressed interests.

General information about tutorials and tutorial schedules is published via the faculty-wide learning management system to provide students with information. The learning management system is also used to provide tutees with learning materials, such as files containing the course presentation or extra materials. The faculty-wide content management system serves as a booking system for courses and enables an electronical registration as well as the establishing of an individual schedule for the tutees since each course can be booked

Table 2. *Supervision of tutors*

	First-Time Tutor	Second-Time Tutor (Same Topic)	Second-Time Tutor (Different Topic)	Repeatedly Active Tutor	Tutor with Exceptional Performance
Categories of tutorials	REX, CON	REX, CON	REX, CON, STE	REX, CON, STE	REX, CON, STE, EXC, ELE
Workplace- based training	Compulsory	Voluntary	Voluntary	Voluntary	Voluntary
Intensive training	Voluntary	Voluntary	Voluntary	Voluntary	Voluntary
Individual consultation	Compulsory	According to the tutor's needs	Compulsory	According to the tutor's needs	According to the tutor's needs and concept of the tutorial
Supervision	Contents and didactic concept	New didactic concepts	New contents	According to the tutor's needs	Supportive, tutor acts mainly independently
Subject and topic selection	According to the tutor's preferences and qualifications	According to the tutor's preferences and qualifications	According to the tutor's preferences and qualifications	According to the tutor's preferences and qualifications	Individual experience and specialization
Selection of methods	Tutor's ideas, experience, determined methods, workplace-based training	Based on previous experience and evaluations, implementation of skills taught through the tutor qualification program	Based on previous experience and evaluations, implementation of skills taught through the tutor qualification program	Based on previous experience and evaluations, implementation of skills taught through the tutor qualification program	Based on previous experience and evaluations, implementation of skills taught through the tutor qualification program

CON, concomitant tutorials; ELE, electives; EXC, tutorials that exceed the formal curriculum; REX, tutorials for reexamination preparation; STE, tutorials for the preparation for the first state examination.

separately. Before a course starts, a paper-based participation list is generated based on the data obtained by the booking system and handed out in the respective course. The participation is confirmed by signature to count the actual number of participants.

#### Data Analysis

Data on the tutorial schedules, the participating tutors and tutees, and the courses and lessons of a tutorial, as well as the evaluation results, were analyzed retrospectively. To analyze the development of the program, every tutorial was assigned to one tutorial category (REX, CON, STE, EXC, or ELE), and the year of its implementation was identified. Since the number of courses and the individual length of a course within a tutorial vary, we chose to determine the number of lessons as an objective parameter for the size of the program. Herewith, one lesson is defined as a teaching session of 45 min.

The number of tutors who were active in each year was analyzed and subdivided into first-time tutors and tutors who had been active in the previous year(s). In addition, the proportion of tutors who were in their preclinical studies, clinical studies, or practical training was calculated for the academic year 2015/16. Tutors with no medical background (e.g., physicists or biochemists), who supported individual tutorials or electives, were listed as “nonmedical” tutors.

Participation lists of the year 2015/16 were digitalized, and the number of participants counted. The participants were further characterized by their academic progress. A student who had paused his or her studies was not assigned to any academic year.

The courses of the peer teaching program have been constantly evaluated by the participants on a voluntary and anonymous basis using paper-based evaluation forms. The evaluations were designed and analyzed with the evaluation software Zensus direkt (version 5.4.3 ziab, Blubbsoft). Routinely, they contained nine close-ended questions with a five-point Likert scale (42). Furthermore, the evaluation included two open-ended questions for additional commentaries. Additionally, since 2011/12, the participants have been asked to grade the respective course. At the beginning, each tutorial (composed of multiple courses) was assessed by only one single evaluation. Since 2011/12, each individual course has been evaluated separately. Quantitative analysis of raw data and data visualization were performed

with the program SPSS Statistics (version 21, IBM). For this study, three exemplary questions were analyzed for each year to obtain an insight into the overall evaluation of the program. The proportions of responses relative to the total number of responses for each value on a five-point Likert scale were calculated for each year. To analyze the variations of the evaluation results from 2011/12 to 2015/16, the means and the SDs of the proportion of each value of the Likert scale for the 5 yr were calculated. Data about the number of participants and the response rates of evaluations have been collected since 2014/15.

## RESULTS

### Development of the Program

**Implementation of tutorials.** An overview of the development of the tutorials and tutorial categories of the peer teaching program from the academic year 2008/09 to 2015/16 is depicted in Fig. 1. In accordance with the initial aim of the peer teaching program to support the preparation for reexaminations, three tutorials of the category for REX mark the implementation of the program in 2008/09. In the second year, the program was expanded by another three subject-specific tutorials for the REX. Furthermore, four tutorials that were held concomitantly to the formal curriculum defined a new category of tutorials (CON). Three years after the implementation of the peer teaching program, almost all subjects of the preclinical curriculum were addressed with either tutorials for REX or tutorials for CON. With the implementation of clinical excursions, a new category of tutorials that exceed the curricular content (EXC) was added in the fourth year to the peer teaching program (2011/12). Since then, 6–7 clinical excursions and 11–15 clinical excursions for freshmen have been offered each year. In 2012/13 and 2013/14, tutorials of another two categories addressing the preparation for the first state examination (STE) and electives (ELE) were introduced to the program, respectively. In the academic year 2013/14, a tutorial in pharmacology and in 2015/16 one in emergency medicine

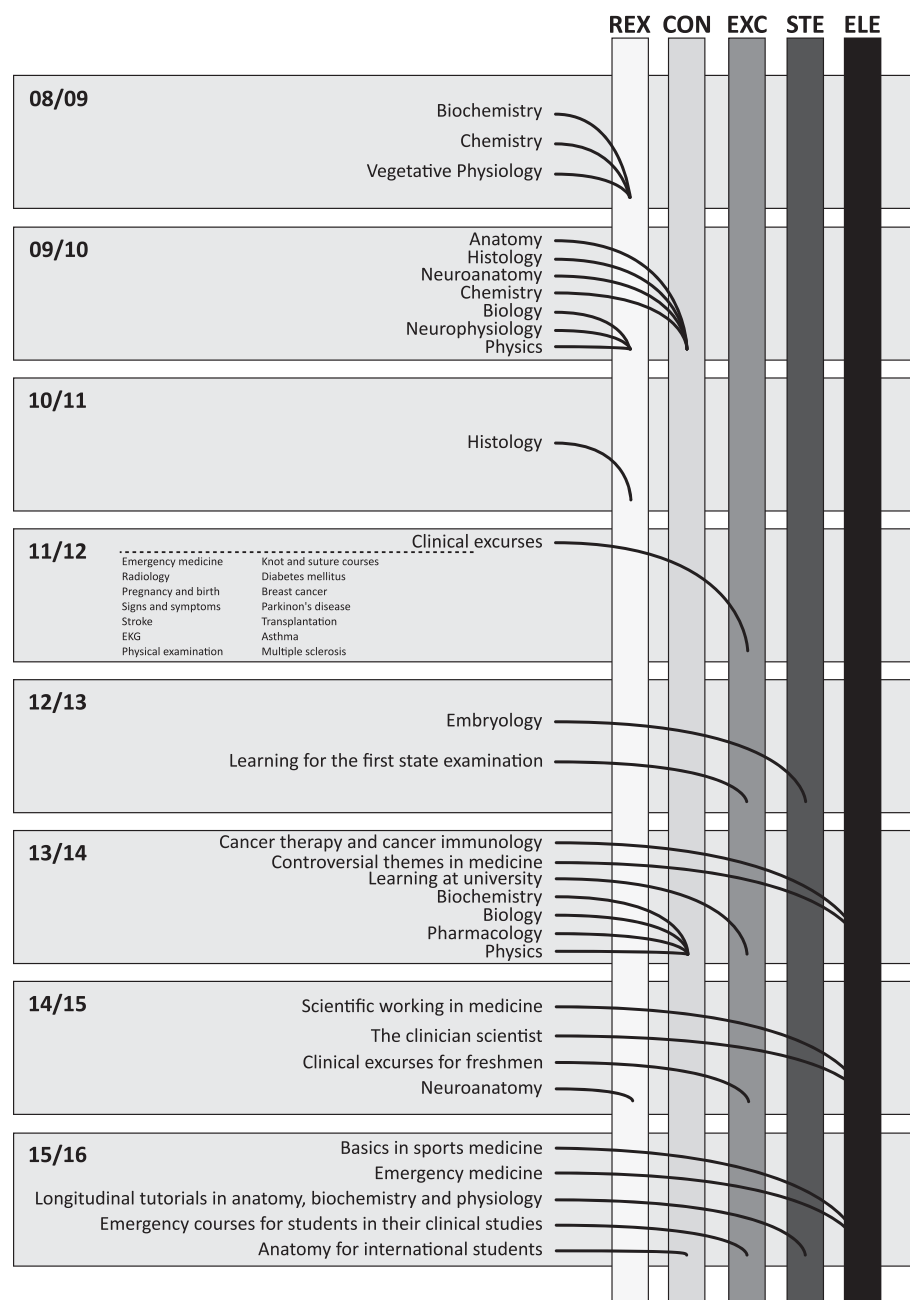


Fig. 1. Implementation of tutorials into the peer teaching program. New tutorials that have been implemented into the peer teaching program are listed in accordance with their year of implementation. The shaded horizontal boxes represent the academic year. The vertical bars represent the different types of tutorials (CON, concomitant tutorials; ELE, electives; EXC, tutorials that exceed the formal curriculum; REX, tutorials for reexamination preparation; STE, tutorials for the preparation for the first state examination). The curved lines connect the tutorials to the respective tutorial category. Clinical excursions have been offered since the academic year 2011/12 with different topics each year (as listed).

were added to the program, the first tutorials designed for clinical students. From 2013/14 to 2015/16, further tutorials were implemented in all five categories. In 2015/16, a new target group was specifically addressed with tutorials for international students.

With the exception of specific topics of electives and clinical excursions, all implemented tutorials became an inherent part of the peer teaching program and thus were offered in the following years. Starting off with three tutorials in one category in the implementation year, the program grew until it consisted of 52 tutorials clustered in 5 categories in 2015/16.

**Number of lessons.** Besides the number of tutorial categories and tutorials, the overall number of lessons has increased from 310 to 2,750 within 8 yr (8.7-fold; Fig. 2). Three hundred ten lessons for REX tutorials were held in 2008/09 as the sole

component of the program. In the following 3 yr, the number of lessons assigned to REX tutorials increased up to 863 lessons in 2012/13. Until 2012/13, the number of lessons of the REX tutorials dominated the program. In 2013/14, the number of lessons assigned to the other tutorial categories (CON, EXC, STE, and ELE) exceeded the number of lessons assigned to REX; 50.7% of the lessons were held as tutorials of other categories than REX. In 2014/15, the number of lessons of CON tutorials alone exceeded the number of lessons of REX tutorials (871 and 870, respectively). In 2015/16, the proportion of lessons referring to the different categories shifted further to 34.2% REX, 46.3% CON, 6.3% EXC, 9.2% STE, and 4.0% ELE.

**Number of tutors.** Consistent with the increase in the number of tutorial categories, tutorials, and lessons, the number of

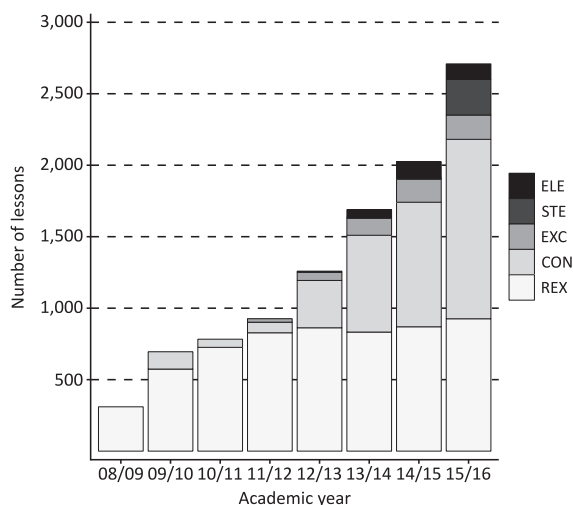


Fig. 2. Extent of the peer teaching program. The development of the peer teaching program is shown according to the number of lessons and their partition to different tutorial categories. One lesson is defined as a teaching unit of 45 min. CON, concomitant tutorials; ELE, electives; EXC, tutorials that exceed the formal curriculum; REX, tutorials for reexamination preparation; STE, tutorials for the preparation for the first state examination.

active tutors per year has increased as well (Fig. 3). Starting with 24 tutors in the academic year 2008/09, the number of tutors teaching in 2015/16 reached 140 tutors. With the exception of the program's first year, both first-time tutors and tutors who had been active before led tutorials. Between 22 tutors (2011/12) and 73 tutors (2015/16) were newly recruited each year.

### Quality Management and Evaluations

Figure 4 displays the summarized results of three exemplary questions of a standardized questionnaire from the academic year 2008/09 to 2015/16. Questionnaire responses are depicted as percentages of responses within the five-point Likert scale for each year. On average, >90% of the respondents "strongly agreed" or "predominantly agreed" with the statements regarding the performance of the tutors (*question 1*) and the recommendation of the courses (*question 2*) and rated the courses as "excellent" or "good" (*question 3*). From 2011/12 to 2015/16, on average 70.9% (SD = 2.2) of the respondents ( $n = 39,641$ ) "strongly agreed" and 22.2% (SD = 1.5) "predominantly agreed" with the statement that the tutor addressed questions very well (*question 1*). There were 70.7% (SD = 1.4) of the respondents ( $n = 40,157$ ) who "strongly agreed" and 21.3% (SD = 1.5) who "predominantly agreed" to recommend the course on all accounts (*question 2*). There were 62.7% (SD = 4.9) of the respondents ( $n = 38,304$ ) overall who rated the course as "excellent" and 29.9% (SD = 3.0) as "good" (*question 3*). The evaluation response rates in 2014/15 and 2015/16 were 83.7% and 84.9%, respectively.

### The Peer Teaching Program in 2015/16

To obtain a comprehensive insight into the program, the tutorials, tutors, and tutees of the academic year 2015/16 were visualized in Fig. 5. The program offered 52 tutorials in all five tutorial categories. Altogether, 2,750 lessons were conducted in 881 courses. Tutorials of the categories REX, CON, and

STE were offered for almost all subjects of the preclinical part of the medical studies. In addition, tutorials for clinical students were conducted in pharmacology. A total of four electives (ELE) were executed. Among the EXC tutorials the program offered 6 clinical excursions for preclinical students, 13 clinical excursions for freshmen, 1 emergency course for clinical students, 1 for visiting students, and 2 tutorials on learning strategies.

The tutorials were led by 140 tutors from all parts of the medical studies (Fig. 5, *right* chart pie). In detail, 22.3% of the tutor cohort were studying in the preclinical part, 60.4% of the tutors studied in the clinical part, and 15.8% were in their practical training. In addition, two nonmedical students, representing 1.5% of the tutor cohort, were active in the peer teaching program.

The tutors conceived tutorials for a total of 1,938 tutees (Fig. 5, *left* chart pie). In detail, 68.9% of all enrolled preclinical students ( $n = 1,223$  of 1,800) and 22.2% of all clinical students (361 of 1,623) participated in the program. In addition, 354 students who were not assigned to any academic year or semester attended courses of the program. The latter group either had not fulfilled the requirements to continue their studies or had paused due to personal reasons. There were 93.5% of the survey responses of the participants in 2015/16 who rated the courses overall as "good" or "excellent" ( $n = 13,489$ ).

### DISCUSSION

Here, we presented a large-scale peer teaching program and analyzed its development and acceptance since its implementation in 2008/09. The program mainly offers extracurricular and voluntary courses complementary to the formal curriculum. The main objectives of this program are to individually support students concerning their medical curriculum and to provide courses and qualification possibilities for interested students. Therefore, courses have been specifically tailored to prepare students for reexaminations (REX tutorials), to support students in the formal curriculum (CON tutorials), to provide an outlook beyond the formal curriculum and foster learning

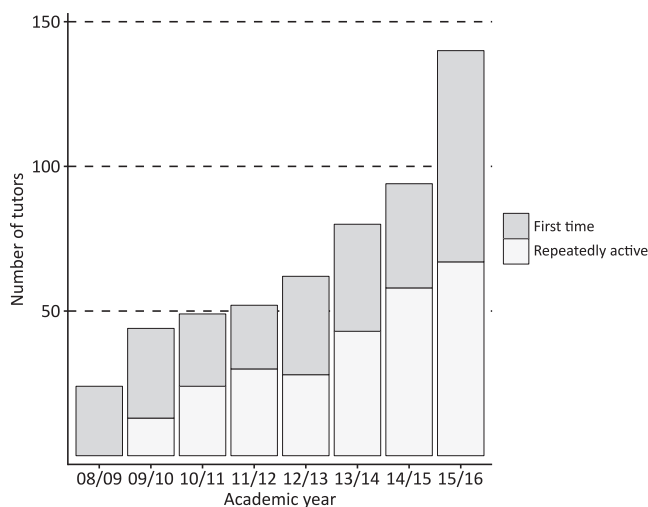


Fig. 3. Tutors in the peer teaching program. The numbers of tutors are plotted for each academic year. The proportion of first-time tutors (dark shaded) and tutors who had been active at least once before (light shaded) is displayed.

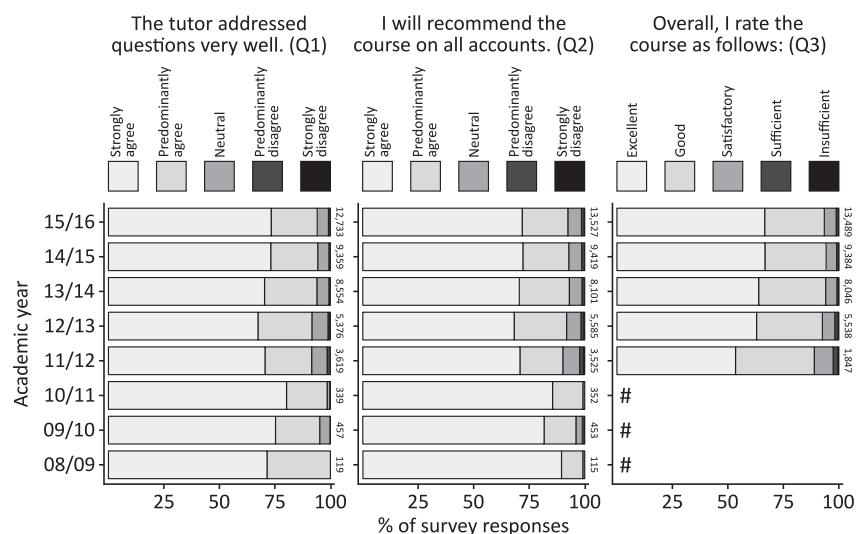


Fig. 4. Summarized results of the evaluations. The evaluation results were consolidated within an academic year. Evaluations contained indicated questions with a five-point Likert scale [question 1 (Q1) and question 2 (Q2): 1 = strongly agree, 2 = predominantly agree, 3 = neutral, 4 = predominantly disagree, 5 = strongly disagree; question 3 (Q3): 1 = excellent, 2 = good, 3 = satisfactory, 4 = sufficient, 5 = insufficient]. Likert scale ratings are depicted in different grayscales (shown above the graphs) as proportions of the total response. Data are presented as the proportion of answers given for a specific question in relation to the overall number of answers, in percent. The total numbers of responses are indicated to the right of the respective bars. # Data on overall rating (Q3) were not available for the initial 3 yr.

strategies (EXC tutorials), or to prepare for the state examination (STE tutorials). As well as this, the program offers electives (ELE) and a qualification program for student tutors. A quantitative analysis revealed that, within 8 yr, the number of tutorials and the number of tutors have greatly increased: In 2008/09, 3 tutorials were led by 24 tutors. By 2015/16, 52 tutorials (altogether 2,750 lessons) were offered that were conducted by 140 tutors. The program was used by almost 2,000 participants in 2015/16. Despite its considerable growth in size, on average, 90% of the evaluation responses have consistently rated the tutorials as “good” or “excellent.”

### Comparison to Other Programs

Nowadays it is common to use PAL in medical education, either in curricular or extracurricular settings (19, 28, 41). Medical faculties make more and more use of the manifold advantages of peer teaching and thereby individualize study possibilities by widening the teaching offers and/or support of the formal curriculum (19, 45). Nevertheless, strategies to implement peer teaching differ. Most published programs predominantly offer courses to specifically train clinical skills (12, 23, 49) or technical skills (29, 38), clinical examinations (5, 11,

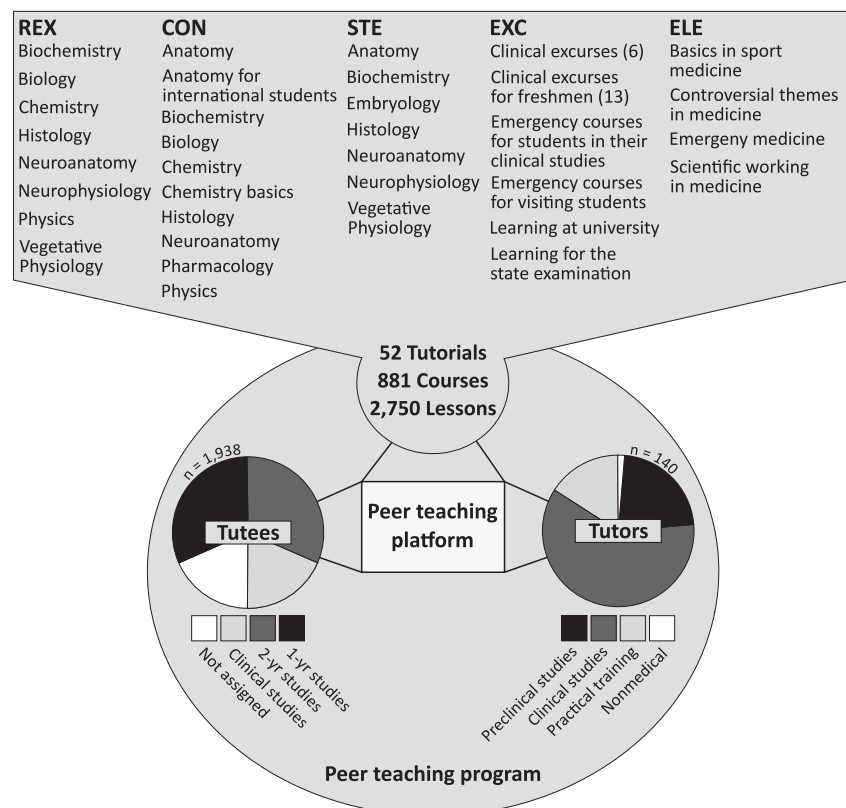


Fig. 5. Schematic overview of the peer teaching program in 2015/16. The different elements of the peer teaching program in the study year 2015/16 are depicted. *Top*: 52 tutorials listed with respect to their category and with overall numbers of courses and lessons. *Bottom*: tutees (*left*) and tutors (*right*) with overall numbers and academic progress. CON, concomitant tutorials; ELE, electives; EXC, tutorials that exceed the formal curriculum; REX, tutorials for reexamination preparation; STE, tutorials for the preparation for the first state examination.

44), or communication skills (15, 34). Other peer teaching programs were implemented to distinctively improve teaching within one clinical subject, such as neurology or rheumatology (16, 18), or single topics within one subject (28). Within this context, the increase in peer teaching in the recent years is reflected in an increase of the number of programs addressing specific issues. In contrast, only few programs cover a broader spectrum of disciplines. For example, Sammariaee et al. (41) described a peer teaching program in which senior students offer tutorials for preclinical students in five subjects (physiology, anatomy, pathology, biochemistry, and pharmacology). These tutorials aim to consolidate learning matter that is taught in the formal curriculum (41). Our program comprises tutorials for almost all disciplines of the preclinical studies, as well as pharmacology and emergency courses for clinical students and tutorials that exceed the contents of the curriculum. Furthermore, while the program initially focused on the reexamination preparation, it continuously transformed into a comprehensive program encompassing tutorials to complement various aspects of the formal curriculum. To our knowledge, our peer teaching program is unique in its size, development, and diversity of tutorials. The growth of the program might be ascribed to the architecture of the peer teaching platform: the program is coordinated by one academic group consisting of research associates from different disciplines. Unlike other programs (1, 2), this group is responsible for the content-related supervision, fulfills coordinative duties, and performs didactic trainings, as well as the evaluation of the content-related knowledge of the tutors. This setting might foster an effective adaption to the tutees' needs through the direct communication among research associates and tutors, which is reflected in the continuous implementation of new tutorials, interdisciplinary tutorials (e.g., STE), and tutorial categories. The development of the program is framed by the expertise of the research associates in the work group. The concentration of content experts of different fields in one group might be an explanation for the growth of the number of peer teaching offers within this program. Besides the advantages discussed above, this might also be the limiting factor for further growth of the program, since not all disciplines of the formal curriculum are covered within the group. However, the further expansion of the program could be realized by applying other strategies of quality management, such as involving external content experts.

### *Tutees*

The program offers tutorials for students in the preclinical as well as the clinical part of the curriculum. In a previous study, our group showed that the peer teaching program is used by students whose failure rate for all major examinations varies from zero to more than five fails in first examinations (42). Hence, the program seems to suit the heterogeneous cohort of participants regarding their academic level and their academic performance. A distinctive feature of the program is the diversity of the offered tutorials. Each participant can decide according to his or her individual preferences which course of which tutorial best fits his or her needs or interests. Evidence for the success of the peer teaching program might derive from the fact that participants of peer teaching tutorials scored higher in biochemistry reexaminations compared with nonparticipants (42). However, it remains unclear whether these

students benefit mainly from the content-related support provided by the tutorials, or if the specific reviewing techniques or a motivational boost can be accountable for improving the examination results. Nevertheless, good evaluation results and high participation showed that the program is well accepted among students. However, more studies are needed to characterize the participation pattern of tutees to further develop and adapt the program to the tutees' needs and to define the benefit for tutees.

In general, peer teaching seems to take advantage of a similarity of tutee and tutor. The concept of social and cognitive congruence attempts to explain this effect. In principle, social and cognitive congruence are described as the similarity of thinking and reasoning of tutor and tutee as an essential condition for the efficiency of peer teaching. The cognitive congruence arises from the similar level of knowledge between the tutor and the tutee. Tutors recognize and understand the problems and needs of tutees, as they have had experienced these not long ago themselves (26). Social congruence implies that the (social) roles of tutor and tutee are similar. Both, social and cognitive congruence, may foster the knowledge transference (30). In the predominantly scientific environment of the preclinical curriculum where most of the lecturers are scientists, tutors who have already reached the clinical part of their training might function as role models. They can forward knowledge gained during their preclinical and clinical training and thereby bridge the gap between basic scientific disciplines and clinical interest of the medical students in the preclinical part.

### *Tutors*

Consistent with the increase in the number of lessons, the number of tutors has increased throughout the years. Remarkably, each year the tutor cohort consisted of repeatedly active tutors, who had at least been active since the previous year, and first-time tutors. The cohort of 2015/16 was composed of students from all parts of the medical studies, namely, in their preclinical studies, in their clinical studies, and in their practical training. These data reflect the admission procedure of the program: Students may enter the peer teaching program as a tutor at any level of their studies (except for their first preclinical semester) (42). The participation as a tutor in the program is voluntary. While in the first years of the program tutors were actively recruited, all tutors who entered the program within the last 4 yr applied on their own initiative.

The considerable number of tutors and their willingness to actively conceive and lead tutorials might be explained on the basis of the self-determination theory (SDT). The SDT is increasingly discussed as a possible concept of how motivation can be promoted (13). In brief, the SDT postulates the distinction between autonomous and controlled motivation (8). Autonomous motivation subsumes intrinsic motivation and extrinsic motivation when an activity's value is in concordance with one's own sense of self. In contrast, controlled motivation derives from psychological pressure or impending punishments. It is argued that autonomous motivations result in more effective performance (8). Within our program the autonomous motivation might be fostered through the volunteering to participate in the program and the possibility to express individual preferences regarding the field of activity. Tutors may conceive

and lead tutorials with respect to their individual strengths and focuses. While some tutors choose to convey only one specific topic within one tutorial, others might teach more topics or discover new tutorial categories for themselves, such as STE, EXC, or ELE. Other aspects that may foster the autonomous motivation are intrinsic and extrinsic rewards. In peer teaching programs, intrinsic rewards might comprise an enjoyable experience, satisfaction deriving from being able to help fellow students, as well as gaining more knowledge and developing (teaching) skills. Extrinsic rewards are mirrored in our program in an employment as assistants and the possibility to participate in university-approved training programs that are certified after successful completion (40). We further hypothesize that the peer teaching program not only supports students in their studies, but also promotes student tutors concerning their subject knowledge and teaching skills, the latter ones being not well-integrated into the curriculum of most universities (33). However, further research is needed to get insights in what motivates tutors and how they benefit from the participation in the peer teaching program.

### Conclusion

Here we presented a peer teaching program implemented mainly beyond the formal curriculum. Unique features of the program include its enlargement, the centralized and faculty-internal organization of all elements of the program, the broad spectrum of courses, and the focus on all participants: the tutees and tutors. Taken together, we conclude that this large-scale peer teaching program complements the formal curriculum and, furthermore, enables interested students to choose courses that exceed the contents of the formal curriculum or electives. We showed that a considerable share of students could be reached. The evaluation results have remained “good” or “excellent” throughout the years. However, this study predominantly highlights the structural framework of the program. It remains to be determined how the participation in the program, either as tutee or as tutor, influences the learning outcomes, including the gain of didactical skills. Further studies will be needed to clarify these questions to further develop the program toward the adaption of the tutees’ and tutors’ needs.

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### DISCLAIMERS

Any opinions expressed here are those of the author.

### DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

### AUTHOR CONTRIBUTIONS

D.E., E.K., B.O., and K.D. conceived and designed research; D.E., E.K., B.O., and K.D. analyzed data; D.E., E.K., and K.D. interpreted results of experiments; D.E., E.K., and K.D. prepared figures; D.E., E.K., B.O., and K.D. drafted manuscript; D.E., E.K., B.O., and K.D. edited and revised manuscript; D.E., E.K., B.O., and K.D. approved final version of manuscript.

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