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Quality Indicators for the Development and Didactics of Ultrasound Courses in Continuing Medical Education

Qualitätsindikatoren für die Konzeption und Didaktik von Ultraschallkursen in der ärztlichen Fort- & Weiterbildung

Authors

M. Hofer[1], L. Kamper[2], F. Miese[3], P. Kröpil[3], C. Naujoks[4], J. Handschel[4], N. Heussen[5]

Affiliations

[1] AG Medizindidaktik, Univ.-Klinikum, Düsseldorf
[2] Department of Diagnostic and Interventional Radiology, HELIOS Clinic Wuppertal, University Hospital Witten/Herdecke
[3] Department of Diagnostic and Interventional Radiology, University of Düsseldorf, Medical Faculty
[4] Department of Cranio- and Maxillofacial Surgery, University of Düsseldorf, Medical Faculty
[5] Department of Medical Statistics, RWTH Aachen University

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Correspondence
PD Dr. Matthias Hofer
AG Medizindidaktik,
Univ.-Klinikum
Moorenstr. 5
40225 Düsseldorf
Germany
Tel.: ++ 49/2 11/8 11 07 43
Fax: ++ 49/2 11/8 11 07 46
matthias.hofer@uni-duesseldorf.de

Zusammenfassung

Ziel: Basierend auf Evaluationsdaten aus Teilnehmerrückmeldungen sollte stufenweise ein, in Hinsicht auf Lernerfolg pro Zeit, optimiertes Ablaufkonzept für mehrtägige Sonografiegrundkurse des Abdomens entwickelt werden.

Material und Methoden: Dieses Konzept ist nach den Erkenntnissen der Lehr-/Lernforschung und den Erfolgen in abschließenden Kursprüfungen im OSCE-Format [2] über mehrere Jahre mithilfe detaillierter Rückmeldungen von ca. 2000 ärztlichen Kursteilnehmern jährlich modifiziert und so stufenweise optimiert worden. Dazu wurden die letzten 1005 konsekutiven Teilnehmerrückmeldungen analysiert.

Ergebnisse: 1005 Teilnehmerrückmeldungen ergeben die Empfehlung eines modularen Kursaufbaus mit nur kurzen Theorievorträgen (optimale Dauer 20 Min., SD 9,6 Min.), im alternierenden Wechsel mit längeren praktischen Schallübungen (60 – 90 Minuten, insgesamt mindestens 50 – 60 % der Kurszeit), vertiefenden Zeichenübungen und Wechselpausen. Als ideale Gruppengröße in den praktischen Übungen geben 51 % der ärztlichen Kursteilnehmer fünf und 43 % sogar nur vier Teilnehmer pro Gruppe an. Die Diskussion stellt zehn konkrete Qualitätsindikatoren für effiziente Ultraschallkurse vor, beleuchtet die Machbarkeit und logistischen Voraussetzungen dieses Modells und vergleicht es mit anderen Grundkurskonzepten. Flankierend wird ein Modell für eine kurskonzept- und ausbilderbezogene Evaluation und ein Trainingsprogramm für Ausbilder inklusive Kostenanalyse vorgestellt.

Schlussfolgerungen: Die Teilnehmer bewerten das entwickelte Kursdesign als ausgereiftes Konzept, das seine Machbarkeit und hohe Akzeptanz unter ärztlichen Kollegen unter Beweis gestellt hat.

Abstract

Purpose: Based on evaluation data from participant feedback, a concept was to be developed for introductory abdominal ultrasound courses lasting several days. This approach was to be developed incrementally with the intent of maximizing the learning effect per time.

Materials and Methods: This concept has been modified annually over several years based on the findings of educational research and the scores on final examinations in OSCE format. It has been modified with the aid of detailed questionnaires completed by approximately 2000 participating physicians and has thus undergone incremental optimization.

Results: Analysis of the most recent 1005 questionnaires has shown that participants recommend a modular course design with only brief lectures on theory (average optimal duration of 20 min., SD 9.6 min.). These should alternate with longer practical "hands-on" ultrasound exercises (60 – 90 min., accounting for at least 50 – 60 % of the course time), consolidating drawing exercises, and breaks. 51 % of the physicians specified 5 participants as the ideal group size for practical exercises, while 43 % specified only 4. The discussion presents 10 specific quality indicators for efficient ultrasound courses. It elucidates the feasibility and logistical prerequisites of this model, and compares it with other basic course concepts. Furthermore, this article presents a model for an evaluation covering the course concept and tutors as well as discussing a training program for tutors including a cost analysis.

Conclusion: In summary, the participants estimate the course design to represent a mature concept that has demonstrated its feasibility and broad acceptance among physicians in CME.

Introduction

An increasingly interdisciplinary tool, diagnostic ultrasound, has become a well established imaging modality in both routine clinical and emergency settings. A survey of 1000 physicians preparing for their specialty board certification examinations has shown that most specialists regard ultrasound examining skills as particularly relevant. At the same time they feel that the teaching of these skills is particularly in need of improvement [1]. Standardized practical examinations in OSCE format have currently been developed for ultrasound and may be included in model curricula in medical schools (for example as a component of "internship examinations"). They are also being discussed within the scope of continuing medical education where they are being considered as possible supplementary components of specialty board certification examinations or health insurance colloquiums [2]. The importance of professionalizing ultrasound courses becomes apparent in this setting. It would increase the learning effect among course participants and improve ultrasound tutors' teaching methods. This in turn would partially address the frequently criticized lack of structure in continuing medical education [3–5] in many specialties with respect to this key skill.

Objective

The main purpose of this study was to develop an adaptive model for the didactic optimization of ultrasound courses for continuing medical education that reflects the current state of research regarding learning and memory processes. The intent was to maximize the course participants' practical examination proficiency while striving for a high level of long-term retention of theoretical background knowledge and of the cross-sectional anatomy of the abdomen.

A further goal was to develop a catalog of criteria to help innovative ultrasound course providers to develop their own course designs. These criteria could then be used to examine the specific methodological or didactic potential for improvement of such course designs. This in turn would allow them to make appropriate modifications and, in applicable cases, to optimize the qualifications of their tutors and instruction methods.

Methods

In cooperation with the Marburger Bund Foundation, the Medical Education Group Düsseldorf has offered introductory abdominal ultrasound courses since 1992. Held under the supervision of radiologists and internists, these courses were originally designed for about 80 physicians per year and currently accommodate 120. To date, over 2000 physicians have participated in our 3–5 day ultrasound courses. Approximately 60% of these participants were hospital staff physicians receiving CME (increasing over time), approximately 30% were interns (decreasing over time), and about 10% were specialists and physicians in private practice. A total of 116 tutors completed the tutor qualification and training program, with an annual fluctuation rate of 2–6 tutors.

A modular course was developed to include lectures, interactive quizzes, live demonstrations with single and synchronous double projections of magnified transducers, and practical exercises in small groups with five participants per ultrasound workstation and tutor. The course was supplemented by consolidating drawing exercises for each of 12 standardized imaging planes [6]. The small groups rotated with each new module from one tutor to the next. This gave them the opportunity to give comparative feedback about the efficiency of the practical exercises and instructional styles. In 2010, standardized preparatory assignments based on the literature [7] were added to the course and sent to the participants about two months prior to the course.

The tutor qualifications included a 3D abdominal topography training session and practical teaching and drawing exercises within increasingly shorter time limits, followed by video feedback. Participants trained for the role of examiner in standardized OSCE examinations and difficult course situations with role-play exercises. These included moderating typical conflicts and explaining matters such as the physical origins of artifacts or the fundamentals of image optimization, all within a brief time frame. A coach discussed the potential for improvement and for shortening with the participants. Initially the tutors invested four full days of training and eight 90-minute training sessions. Later the advanced tutors only participated in this training sporadically as trainers for new tutors or as required, depending on their evaluation.

Standardized questionnaires were used to survey all course participants about the quality criteria for the general course design, the learning points, the weighting of the various course phases and breaks, and the potential for improvement. The latter also included the delivery techniques of the tutors, who were evaluated individually and by name.

The results were jointly reviewed and discussed by the team of tutors and lecturers immediately after each ultrasound course and viable options for optimization were identified. Each year changes were made to the method of delivery of theory, the practical exercise phases, and the methodical design of preparatory and consolidating exercises. The effectiveness of these changes was then verified with new evaluation data and standardized OSCE examinations at the end of each respective course [2]. The detailed evaluation results were entered into a chronological trend analysis, which was made available to the tutors shortly after the course along with the participant comments. They also received an anonymous comparison of the results of all tutors.

The frequency of participant comments in the last 1043 consecutive participant evaluation questionnaires was used to rank course characteristics and criteria deemed by participants to contribute to an optimal learning effect in ultrasound courses. Additionally, the results of the participant survey were summarized as relative frequencies and/or mean values and standard deviations (SD). The participants' votes were evaluated in total and analyzed according to the respective survey period (2000–2004, 2005–2007 and 2008–2010).

The evaluation results were compared with a total of 60 external basic abdominal ultrasound courses (2× 30 courses each in the years 2005–2007 and 2008–2010) offered by third parties with respect to group size, course design (block structure vs. alternating structure) and the duration of theoretical presentations. All external courses were attended incognito and scored with the same evaluation form used for the internal courses of our study. The differences between the concepts desired by the participants and those offered by the 60 external

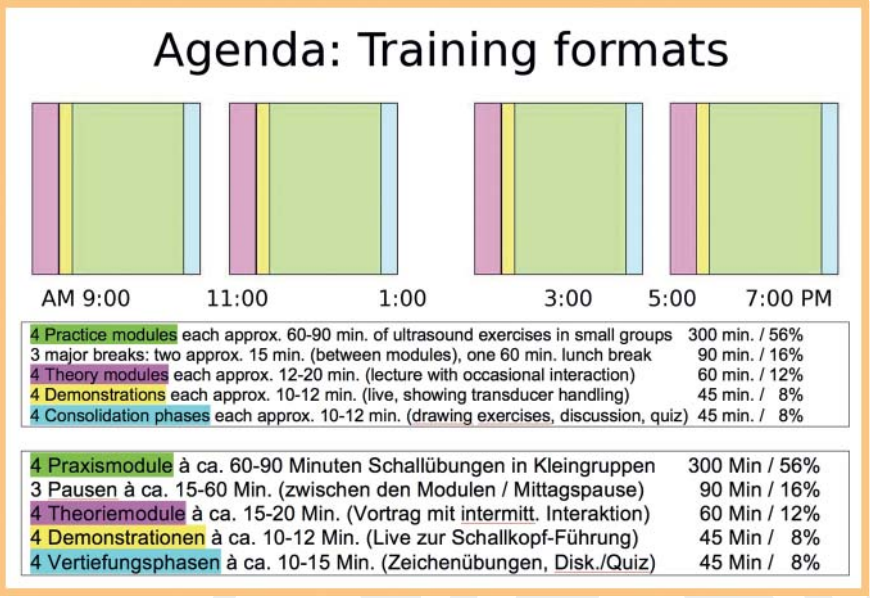

Fig. 1 Flow diagram of a full day of training showing the time weighting of the various modules. Introductory lectures are shown in purple, live demonstrations in yellow, practical ultrasound exercises in small groups in green, and consolidating drawing exercises in blue. Breaks are shown in white.

Abb. 1 Ablaufschema mit zeitlicher Gewichtung eines vollen Trainingstages mit modularem Wechsel zwischen Einführungsvorträgen (violett), Live-Demos (gelb), praktischen Schallübungen in Kleingruppen (grün) und vertiefenden Zeichenübungen (blau) sowie intermittierenden Pausen (weiß).

courses were analyzed using a one-sample *t*-test (length of theory lectures, optimal group size) or binomial test (course concept). All tests were two-sided and assessed at the 5% significance level. Statistical analyses were preformed with the use of SAS®, V9.2 (SAS Institute Inc., Cary, NC, USA).

Inclusion criteria

Only questionnaires that were over 85% complete and contained no contradictory statements were included in the evaluation.

Results

A total of 38 of 1043 questionnaires from the years 2000 through 2010 fell under the exclusion criteria so that 1005 questionnaires (96%) were evaluated. Nearly all course participants favored the following mix of methods for a 9-hour training day for their subjective and objective learning effect in the OSCE examinations (**Fig. 1**).

For retention of the abdominal cross-sectional anatomy, 94.8% of the participants regarded the assisted drawing exercises for the 12 standard imaging planes as "very helpful" or "helpful." Consolidating drawing exercises were not observed in any of the external courses.

Items emphasized as particularly helpful to learning included the brief intervals for changing among the participants actively performing imaging (usually 7 – 10 minutes) and for tutors changing between the individual imaging modules as well as the frequent involvement of participants not actively performing imaging. This included content, quiz, and repetition questions. Passive participants were also asked to give imaging instructions and to operate equipment. Of the participants queried, over 99% supported frequent alternation between brief theory modules and longer practice phases. They explicitly decided against a course designed in blocks with several successive lectures (for example in the morning) followed by practical exercises. Only 0.7% favored a longer theory block followed by a practice block (**Table 1**).

The design of the 60 visited external courses has the opposite structure (75% block structure with 25% alternating structure). In the early survey period (2005 – 2007), the percentage of courses with a block structure was 88%; in the second survey period (2008 – 2010), it dropped down to 2/3. In these time periods 99% of participants desired an alternating structure, while 0.37% and 0.82%, respectively, favored a block structure (**Table 1**). The design of the external courses in both survey periods thus differed significantly ($p < 0.0001$) from the wishes of the participants we surveyed. The optimal length of theory lectures (**Table 1**) was specified on average as 20.0 minutes (SD 9.6). With four theory modules planned, their total desired duration represents 15% of the course time. This desired value differs significantly ($p < 0.0001$ in each case) from the lengths of the theory lectures in the external ultrasound courses. In the early survey phase 2005 – 2007, these lectures averaged 56.3 minutes (SD 13.5; 72% of total course time); in the second survey period 2008 – 2010, they averaged 46.8 minutes (SD 11.2; 67% of total course time).

The optimal average group size for practical exercises was specified as 4.5 (SD 0.69) per workplace and tutor in both survey periods. In our courses the number of participants per group was 5. This value differed significantly ($p < 0.0001$ in each case) from the group size of the external ultrasound courses, which in the early survey period was on average 8.1 (SD 1.0) participants per group and in the second survey period 6.9 (SD 1.2). Of our participants, 54.34% stated they were willing to pay higher course fees for groups smaller than 5, while 45.66% rejected this proposal and felt that a group size of 5 was optimal.

The course participants specified 9 items as essential quality indicators for the maximization of their learning effect, which are listed in descending order in **Table 2**.

Discussion

Prior to any interpretation of the results, it should be considered that some constellations of increasing clinical workload coupled with problems in acquiring qualified staff are not con-

Table 1 Results of participant survey (percentage and mean (SD)) according to survey period.

		Survey period			Total
Item n per item total (per survey period)		2000 – 2004 n = 359	2005 – 2007 n = 275	2008 – 2010 n = 371	**2000 – 2010 n = 1 005**
Training background					
n = 966 (349/266/351)	Student/intern	58.17%	26.69%	8.55%	**31.47%**
	Resident	37.25%	65.79%	76.92%	**59.52%**
	Hospital staff specialist	2.87%	6.39%	9.97%	**6.42%**
	Private practice	1.72%	1.13%	4.56%	**2.59%**
Age					
n = 996 (254/273/369)	20 – 25	7.06%	12.09%	7.05%	**8.43%**
	26 – 30	59.89%	47.25%	42.55%	**50.00%**
	31 – 40	6.84%	31.50%	32.52%	**30.22%**
	> 40	6.21%	9.16%	17.89%	**11.35%**
Concept					
n = 994 (354/272/368)	In blocks	0.85%	0.37%	0.82%	**0.70%**
	Alternating	99.15%	99.63%	99.18%	**99.30%**
Time allotment					
n = 965 (333/268/364)	Optimal	19.82%	21.27%	31.04%	**24.46%**
	Pleasant	41.44%	45.52%	45.33%	**44.04%**
	Strenuous	38.14%	32.09%	23.35%	**30.88%**
	Very strenuous	0.60%	1.12%	0.27%	**0.62%**
Drawing exercise					
n = 996 (357/272/367)	Very helpful	52.66%	54.78%	58.31%	**55.32%**
	Helpful	40.90%	39.34%	38.42%	**39.56%**
	Not very helpful	5.88%	5.15%	2.45%	**4.42%**
	Not helpful	0.56%	0.74%	0.82%	**0.70%**
Group size = 5					
n = 992 (350/274/368)	Optimal	42.00%	55.11%	55.16%	**50.50%**
	Acceptable	50.57%	39.42%	38.04%	**42.84%**
	Too large	7.43%	5.11%	6.25%	**6.45%**
	Far too large	0.00%	0.36%	0.27%	**0.20%**
Higher costs for smaller groups?					
n = 968 (346/269/353)	Yes	55.49%	56.13%	51.84%	**54.34%**
	No	44.51%	43.87%	48.16%	**45.66%**
Prior mailing of textbook and assignment					
n = 115 (–/–/115)	Very helpful	–	–	69.57%	**69.57%**
	Helpful	–	–	29.57%	**29.57%**
	Not very helpful	–	–	0.87%	**0.87%**
Optimum lecture duration					
n = 925 (334/255/336)	Minutes	20.8 (SD 9.3)	19.9 (SD 10.0)	19.4 (SD 9.6)	**20.0 (SD 9.6)**

Table 2 Quality indicators for optimal learning effect in ultrasound courses from the participants' perspective.

Course emphasis on long practical ultrasound exercises
Increasingly brief and only intermittent theory phases (lectures)
Small practice groups of at most four to five participants
Experienced tutors and lecturers with specialized training in the subject and in didactic methods
Frequent change of media in the theory phases (PPT slides, films, live demonstrations, quizzes)
Active participation constantly required in the form of: drawing exercises, quizzes, consolidating questions
Tangible consideration of the needs of the participants and their learning effect
Opportunity for systematic preparation (mailing literature and assignments)
Sufficient length and number of breaks

ducive to implementing all of the recommendations outlined below for ultrasound courses. However, that was never a premise of this study. On the contrary, this long-term study is intended to develop an adaptive model based on continual re-evaluation from which each course director can apply those elements that are feasible and expedient in the respective setting.

The model presented here is based on course experience with a specific group of participants consisting of hospital staff physicians. Their needs are not necessarily applicable to ultrasound refresher courses for general practitioners in private practice for example. However, the current situation is favorable for measures to improve the quality of CME courses as hospitals compete for qualified staff and increasingly assume the expenses of their residents' CME courses. As a result, there are now new opportunities for improving the tutor-participant ratio, which leads to higher course fees. In this regard it is interesting to note that 54% of participants are explicitly willing to pay higher course fees for groups of 4 in the practical exercises.

Our observations have also shown that evaluations rarely cover both the course concept and the individual tutors. It is also rare for them to request participant feedback about specific persons and to make this information available to the tutors shortly after the course in the form of their personal chrono-

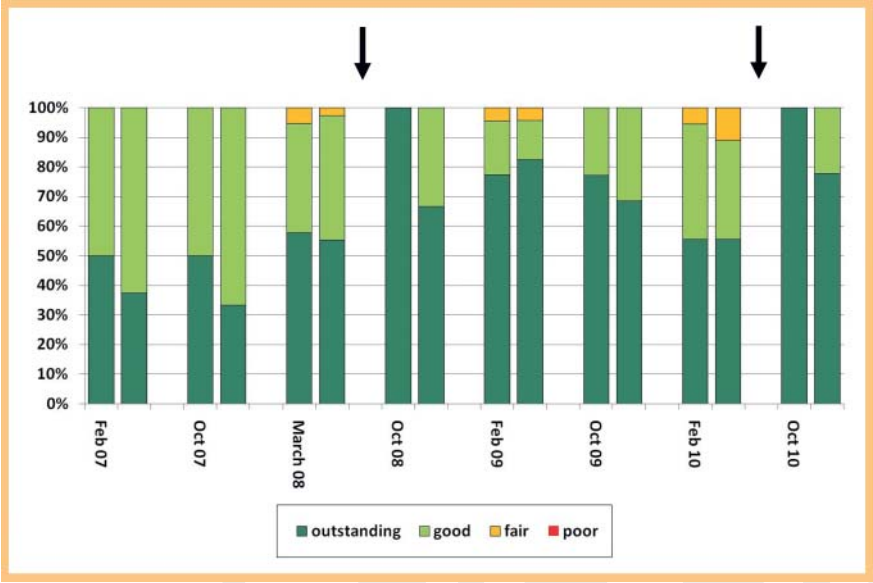

Fig. 2 Example of a chronological trend in a tutor's evaluation results. Participants evaluate the tutor's qualifications with respect to subject matter (left bar) and didactic presentation (right bar). The original is supplemented by participant comments about the tutor. The typical wave-like progression reflects the interplay of "fatigue effects" and performance improvements following training sessions (↓).

Abb. 2 Beispiel eines zeitlichen Trends in den Evaluationsergebnissen eines Ausbilders zur fachlichen (jeweils linke Säule) und didaktischen (jeweils rechte Säule) Qualifikation aus Teilnehmersicht, im Original ergänzt durch den Ausdruck der ausbilderbezogenen Freitextkommentare. Typisch sind wellenförmige Verläufe durch "Ermüdungserscheinungen" und verbesserte Bewertungen nach Schulungsintervention (↓).

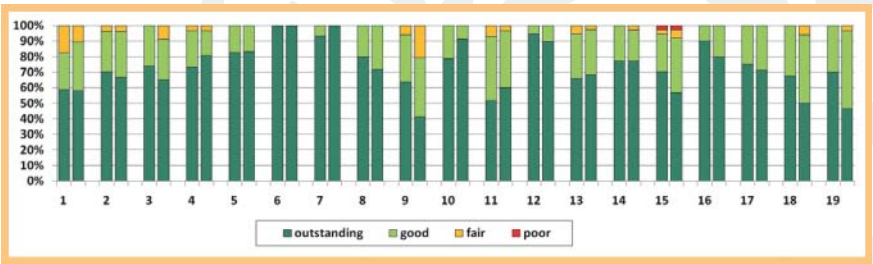

Fig. 3 Example of an evaluation comparison of proficiency with respect to content (left bar) and didactic presentation (right bar) among the 19 tutors of an ultrasound course. The respective tutor is shown only his or her own ID number. The other 18 tutors remain anonymous for that tutor. The tutor's own position within the teaching team is still readily apparent.

Abb. 3 Beispiel eines Evaluationsvergleichs zu den fachlichen (linke) und didaktischen Kompetenzen (rechte Balken) innerhalb der 19 Ausbilder eines Sonografiekurses: Rückgemeldet wird dem Ausbilder nur die eigene Kennziffer. Die anderen 18 Ausbilder bleiben somit für den Einzelnen anonym. Dennoch wird die eigene Position innerhalb des Ausbilderteams transparent.

logical trend (compared with previous courses, ▶ **Fig. 2**) and as an anonymous comparison to the other tutors (▶ **Fig. 3**). This sort of data and the culture of candid reflection that they foster make it easier for the respective tutors to reflect upon and, if applicable, modify their instructional technique in the hands-on exercises. The course directors are more readily able to optimize their own course concept in the interest of quality while providing their tutors with specific training with respect to content and didactic approach. Although the course director received the best evaluation scores on average in our study, several tutors came close to or sometimes even exceeded his ratings, which might provide a challenging motivational aspect among the teachers and tutors.

Therefore, a first step might be to develop a detailed participant course evaluation that is specifically tailored to the individual tutors. It can be helpful to have participants fill out the questionnaires before the end of the course, e.g. prior to the final practice module.

In our concept, the costs per course of such an evaluation and digital feedback to the tutors via email are approximately 20 student assistant hours at €8.56 for a total of about €200 including copying costs. This is about €3.50 per participant or about 1% of the course fee. At a calculated hourly rate of €40 over five work days, the costs of training tutors in our concept totaled approximately €1600 per tutor (distributed over several years). Assuming that a tutor remains on the team for an average of five years and teaches two courses per year, this would represent only fictitious costs of €160 per tutor per course. Our tutors receive no remuneration for their preparation time but voluntarily invest in their own qualifications. They are compensated for this by subsequent tutor salaries.

The results of the present study indicate that the opinion of a majority of the physicians participating in ultrasound courses correlates to a high degree with the results of research regarding teaching, learning, and memory processes [6]: These results indicate that brief theory modules alternating frequently with longer practice phases in small groups should be required. At the same time the survey over two time periods shows that the actual course reality still deviates significantly from this course design in many places. However, its prevalence has doubled from one-sixth originally to one-third in our most recent analysis.

From the course organizers' perspective there are understandable reasons for preferring a long theory block in the morning, i.e., this requires significantly less personnel than an alternating concept with a higher proportion of practical exercises in small groups. The latter requires the constant presence of all tutors and therefore leads to higher personnel costs. Constella-

tions in which the practical exercises are supervised in the afternoon by the course director's clinical assistants, however, will not permit the course design recommended here. This poses the question of whose needs should be given greater emphasis in quality management. Unfortunately, the "convenient" method with its lower labor costs for the course organizers conflicts with the needs of the course participants.

In spite of this, the course fees of our more labor-intensive model at € 350 per participant including catering and preparatory literature are below the average fee for a 3-day ultrasound course in Germany. However, the introductory course design presented here dispenses with ultrasound examination subjects for cost reasons. The participants examine each other under supervision, and upon registration give their consent to let others perform ultrasound examinations on them. For this reason the intermediate and advanced courses with patient presentations requiring more elaborate logistics are more cost-intensive.

Although the block concept warrants critical re-examination from an educational standpoint, relevant improvements in the learning effect can be achieved even without "radical" changes. In particular, mailing literature to course participants beforehand has significantly improved their professional preparation for the course. The literature contains specific preparatory assignments, including exercises such as drawing 12 standard planes from memory, to facilitate pattern recognition and quick orientation within the three-dimensional abdominal space. This helped participants to better handle the drawing exercises (designed as memory aids) and significantly increased their average point score in the subsequent OSCE parcours [2]. The apparent low ranking of participant comments (**Table 1**) is attributable to the very recent introduction of this systematic preparation. Since then, this criterion has become the one that is most frequently mentioned.

According to course participant feedback, the frequent active integration of participants even in the "passive" or observational learning phases has the effect of minimizing fatigue despite the compact, strenuous course structure. This important quality criterion is consistent with findings of educational research, which indicate that a high proportion of practical exercises in small groups leads to the best and most sustainable learning effects [9–11].

Practical exercises in audiovisual synchronization are among the techniques that have proven effective in the specific didactic training of the tutors. Using a trackball to move a high-contrast arrow over the frozen or moving image, the tutors practice pointing out the respective structure while simultaneously delivering a verbal explanation. Consequently, they avoid one of the cardinal errors (**Table 3**), namely pointing out a key structure only intermittently on the monitor with their own hand. Often the tutor's hand will block the view of the relevant parts of the image for those participants who are not performing the ultrasound examination. Unfortunately, most course participants never object to this lack of clarity. This is attributable in part to a lack of familiarity with the more illustrative instructional method, and in part to the risk of subjective embarrassment in having to admit one's own lack of knowledge ("Now, where is the pancreas?").

Table 3 Overview of most frequently observed educational mistakes made by ultrasound tutors.

"High-speed" monologues and self-demonstrations (instead of pauses, interactive discussions and support of the participants' hands-on performance)
Verbal explanations only without synchronized visualization of sectional anatomy
Showing of specific structures with own hand in front of monitor, thus blocking participants' view (instead of using the trackball and a well-contrasted arrow to highlight the relevant pixels)
Lack of awareness of the listening (non-active) course participants (instead of activate tasks to involve them all, e. g. by commands to the sonographer, mental or image quizzes, multitasking)
Use of too many words for circumstantial or complicated explanations (instead of precise verbalization according to KISS principle: keep it short and simple)
Lack of balancing-out of the hands-on time between participants of one group

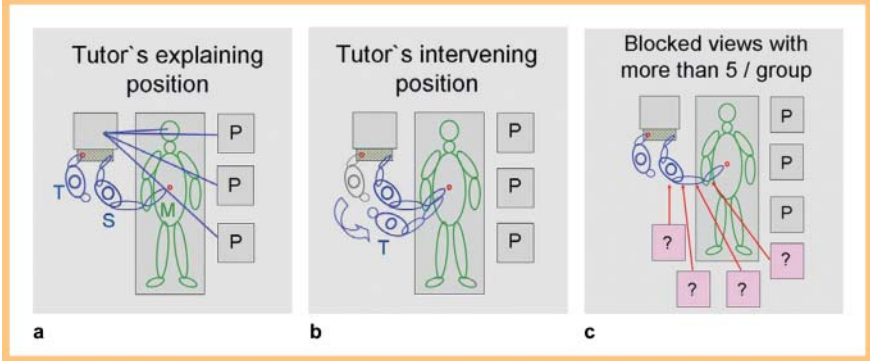

Fig. 4 Optimized position of the tutor (T) in practical exercises: The left hand operates the unit and trackball for explanations on the ultrasound image (**a**). Taking one step forward allows the right hand to help the current sonographer (S) correct the transducer position (**b**). This largely avoids blocking of the line of sight of the remaining participants (P). If more than 3 to 4 passive participants are present, their view of the monitor would be impaired by the sonographer's arm and shoulder (**c**). Adequate rotation and tilt of the monitor is also important for the participant acting as the ultrasound examination subject (M).

Abb. 4 Didaktisch optimierte Standposition des Ausbilders (T) bei praktischen Übungen: Die linke Hand übernimmt die Gerätebedienung/Trackball für Erläuterungen am Sonobild (**a**). Mit nur einem Schritt kann bei Bedarf die rechte Hand in die Schallkopfführung des aktuell schallenden Teilnehmers (S) eingreifen (**b**). So wird die Blickperspektive der nicht schallenden Teilnehmer (P) am wenigsten beeinträchtigt. Bei mehr als 3–4 passiven Teilnehmern wäre der Blick auf den Monitor durch Arm und Schulter des Schallenden versperrt (**c**). Eine adäquate Drehung und Kippung des Monitors ist für den als Schallmodel dienenden Teilnehmer (M) wichtig.

This technique also produces an interesting effect (and one conducive to learning), namely it slows the tutor's speech. The left hand (most tutors are right-handed) cannot move the arrow with the trackball fast enough to keep up with the tutor's speech if he or she speaks too quickly (**Fig. 4a**). During this procedure, the tutor's right hand remains free to help the course participant correct the transducer position if necessary (**Fig. 4b**).

In addition, tutor training is focused on repeated practice of precisely formulated task assignments for the participants performing the ultrasound examination. In training our own tutors and observing other tutors, we repeatedly observed initial random scanning taking place without a specific imaging target (an organ or vascular region). The observers generally had the impression, consistent with the findings of educational research [12], that these unstructured ultrasound practice phases tended to reflect a less obvious training effect as opposed to specific, chronologically limited scanning exercises of a complete organ or the task of measuring the width of a vascular lumen. The most effective instruction exercises proved to be those combined with subsequent video analysis. The "aha" effect of tutors seeing themselves as others see them is achieved much faster. Apparently, it also leads to more permanent changes in behavior than without the opportunity of being able to see and analyze oneself from the perspective of others [13, 14].

The option of being able to conclude ultrasound courses with standardized practical examinations in OSCE format with feedback for one's own learning effect [2] also provides a very effective opportunity to shift the participants' attitude to course participation away from one of passive expectation toward a more active, exercise-oriented attitude. Possible deterrent effects with problems of acceptance in the target group need not be feared among hospital staff physicians. Although there are many regional alternatives without final examinations offered for similar prices, our courses, despite practical examinations, have been rapidly overbooked for years with over 100 registrations per course. Course participants are willing to travel longer distances from northern, eastern, and southern Germany and as far as Switzerland (approx. 40% > 400 km).

The concept can also be applied to 4-day courses (according to KBV directives and §135 (2) of the German Social Security Code V) as the number of hours per day can be reduced and the breaks extended. The authors also offered 5-day introductory abdominal ultrasound courses under the auspices of the German Federal Chamber of Physicians for several years. The longer course duration had positive effects by giving participants opportunities for additional preparation and further study during the course breaks. It is difficult for many hospital staff physicians to take off more than a Friday plus the weekend for such CME courses. As a result, we have deferred to the participants' wishes and have not expanded the compact 3-day course concept to 4 days. Otherwise, our tutors would increasingly encounter problems with taking time off from their own hospitals. Approval of the ultrasound courses according to DEGUM or KBV directives is of secondary importance for the participants surveyed here (< 5%). In Germany, the ultrasound skills required for a particular specialty are usually included in residency skills catalogs, and residents do not normally need to document any additional courses when they later go into private practice.

The present study does exhibit limitations in the comparison with the various external course concepts. Although 30 external basic course models were visited per survey period, it is possible that this limited sample may not be representative of the entire palette of available course concepts and didactic methods. The presented course concept is particularly well suited for introductory courses. At least in its present form it is not readily applicable to intermediate or advanced courses. Future studies with the use of common evaluation forms with comparable quality indicators (items), which should be common-sense among the ultrasound course providers of the national society of ultrasound, are desirable.

Table 4 Ten quality indicators for efficient ultrasound courses.

A tutor-participant ratio conducive to learning: for the hands-on ultrasound exercises, a maximum of 4 – 5 participants per tutor and ultrasound workplace.
Frequent alternation between brief introductions or theory presentations (each about 20 minutes, < 15% of total course time) and longer practice phases (> 50%).
Frequent, active involvement of participants by means of consolidating questions and quizzes, or by requesting them to give imaging commands or operate the ultrasound equipment.
Change of media in lectures (PowerPoint slides, films, board, live demonstrations with separate projection of the transducer position).
Encouragement of the participants to actively repeat and verbalize key points, instead of listening in a "passive" role.
Drawing exercises to help consolidate knowledge of 3D sectional anatomy.
Systematic course preparation required with specific training assignments.
To increase motivation, the course should conclude with an optional test (OSCE) with feedback about the individual participant's learning effect and/or potential for improvement.
System for evaluating the course concept and individual tutors and lecturers, feedback results made available to the lecturers and tutors shortly after the course.
Regular didactic training tailored to the specific level of experience for lecturers and tutors (with video feedback wherever possible).

Conclusion

Based on the participant' statements, our course design represents a mature concept that has demonstrated its feasibility and broad acceptance among physicians in continuing medical education. From the perspective of the participants and tutors, 10 major quality indicators have emerged (**Table 4**).

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