Original Research

Team- and Case-Based Learning to Activate Participants and Enhance Knowledge: An Evaluation of Seminars in Germany

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Introduction: *There is a strong need for high-quality continuing medical education (CME) in Germany. To maintain a medical license, physicians are required to participate in regular training. Although evidence suggests that compared to lectures interactive methods can impart sustainable knowledge and a high degree of satisfaction, few interactive CME courses are offered.*

Methods: *We designed an interactive, team-based CME concept and launched it in a series of seminars on internal medicine. The group work was designed using team-based learning. Pre- and postcourse knowledge tests with an electronic voting system and paper questionnaires (Likert scale 1–6) were used to evaluate knowledge, motivation, and expectations of the participants (n = 159).*

Results: *Participants rated the interactivity and team-based discussion (mean: 4.57, SD: 1.41) of the CME seminars as highly important reasons to participate and stated that the CME course was very instructional (mean: 5.16, SD: 0.84) and the case discussions enhanced their learning (mean: 5.46, SD: 0.75). The majority of participants stated that their expectations were met. The participants enhanced their outcome from a mean of 47.2% right answers prior to the course to 70.3% in the postcourse test ($p < 0.001$).*

Discussion: *An interactive, case-based design of a CME course following the team-based learning concept leads to a significant gain in the participants' knowledge with an identified preknowledge level. Participants' expectations seemed fulfilled by a CME course design, which combines small group discussions in the lecture hall with didactic lectures and intensive discussion.*

Key Words: *continuing medical education (CME), team-based learning, case-based learning, knowledge gain, interactive*

Introduction: Continuing Medical Education—Extensive Research Is Needed

For several years, physicians practicing in Germany have been required to participate regularly in clinical training, after their specialization. This lifelong training in medicine is called *continuing medical education* (CME) or *continuing professional development* (CPD). The requirement to participate creates a need for high-quality and flexible CME courses. In Germany, every physician has to prove that he or she has earned 250 CME credits every 5 years. (See TABLE 1).

Increasing use of Web-based interactive CME offers new possibilities for didactic strategies.[1] Online courses may afford learners the comfort of anonymity and flexibility, widely independent of time and place and with a variety of communication strategies. For practicing physicians outside urban centers, online courses often are the only opportunity to participate in training, without a high cost in time and finances,[2–4] but the effectiveness of online CME courses in changing physician behavior has been questioned.[2] Recent studies of high-quality structured online programs have demonstrated positive outcomes including an increase in knowledge and behavioral change. The results of online courses may be equal to or greater than outcomes of face-to-face programs.[5,6]

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TABLE 1. Medical Education and the Physician Workforce of Germany

Undergraduate medical education (curriculum)

- Admission to medical schools restricted by central federal bureau; criteria for admission: final grade point average on the highest secondary school diploma, waiting list and additional criteria due to state regulations; 2007: 8,377 study places at 36 medical faculties available; 35,033 applicants[a]
- Two years of preclinical classes with medical basic sciences courses: biology, chemistry, physics, macroscopic/microscopic anatomy, physiology, biochemistry, medical psychology, and sociology and 2 months clinical electives in nursing
- National basic sciences examination: written tests (320 multiple-choice questions, MCQ) and oral-practical tests in anatomy, biochemistry, and physiology
- Three years of clinical classes: general medicine, anesthesiology, occupational medicine, ophthalmology, surgery, dermatology, gynecology and obstetrics, genetics, ENT, microbiology, virology, internal medicine, pediatrics, neurology, orthopedics, pathology, pharmacology, psychiatry, urology, forensic medicine, biostatistics, radiology, and 4 months clinical electives in hospitals and outpatient practices
- One-year internship in a university hospital or affiliated teaching hospital: internal medicine, general surgery, and elective speciality (16 weeks each)
- Integrated model curricula offered at five medical schools (no separation between preclinical and clinical courses; no national basic sciences examination)
- Final graduating exam: written tests (320 MCQ) and oral-practical tests in general surgery, internal medicine, elective specialty, and one casted specialty; 2005: 8,870 graduates of medical schools in Germany[b]

Graduate medical education

- Three to six years of structured clinical training to become a specialist in, for example, internal medicine, surgery, dermatology, gynecology, or pediatrics
- Licensing degree awarded by state medical boards through oral examinations
- Physicians required to complete postgraduate training before they are allowed to establish themselves in an outpatient practice; regional restrictions for setting up a medical practice based on overall levels of demand and supply

Physician workforce

- 407,000 physicians in Germany; 311,230 employed (39.9% female), 136,200 working in outpatient practice, 148,300 working in hospitals[b]
- 42,256 general practitioners, 177,250 specialists[b]
- Mean age for doctors working in hospitals and outpatient practice 40.95 years and 51.12 years, respectively[b]
- 19,513 doctors from international medical schools: 70.7% from European countries, 20.2% from Asian countries, 4.3% from African countries, 3.5% from the Americas[b]

Continuing medical education

- Physicians required to participate in regular clinical training after their specialization
- Since 2004, all licensed physicians required to earn 250 CME credits every 5 years (or 150 CME credits every 3 years, respectively)

Note: Compiled by Lisa Kühne-Eversmann, MD, and Martin R. Fischer, MD, MME (Berne); population of Germany: 82,258,000 (September 2007) (Statistical Center of Germany: http://www.statistikportal.de/Statistik-Portal/de_zs01_bund.asp, September 2007).

[a]"ZVS-Daten," Informations- und Pressestelle der ZVS: http://www.zvs.de, August 3, 2007.

[b]Bundesärztekammer: Ärztestatistik 2006: http://www.baek.de/page.asp?his=0.3.5008, December 31, 2006.

There is evidence to suggest that interactive methods such as team-based learning and case method learning, as compared to lectures, can impart sustainable knowledge and high satisfaction among participants.[7–13] Unfortunately, few CME courses are interactive or case-based. Currently most certified CME follows the traditional lecture format with subsequent discussion, producing no significant change in physician behavior.[10,14]

We designed a new, interactive, team-based CME concept and launched it in a series of seminars on endocrinology and diabetes care. After the pilot phase, the design of the CME course was applied to another series of CME activities on topics of internal and general medicine. Three courses with numerous participants from Munich and surrounding areas have taken place and are evaluated in the present study.

Methods

Design of the CME Course

Initially, participants were engaged in team-based learning on important topics focused on patient needs during CME courses (see FIGURE 1). The CME course—live and online—is characterized by the following features: interactive; team- and case-based;[15] related to medical practice; innovative in didactic terms and independent of pharmaceutical influences. The interactive seminars comprise 5 hours of teaching on two topical units with three to four clinical questions on each topic. They begin with a precourse knowledge test with multiple-choice questions in a single best answer format using an electronic voting system. After a short introduction of the topic by an expert, participants are di-

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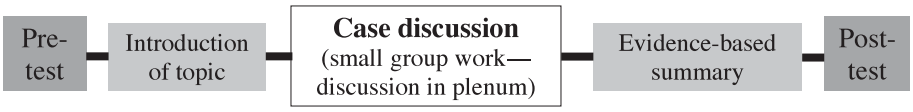

FIGURE 1. Design of the CME course.

vided into small groups of four to six participants. The group work uses team-based learning designed by Michaelsen and colleagues.[15] The groups must make joint decisions on a number of paper cases (case-based learning). All groups then report and discuss their results with the expert in the plenum in a structured way. Finally, an evidence-based summary is presented by the expert. At the end of the course we evaluate with a postcourse knowledge test, to see whether participants show significant gains in knowledge in the topics related to clinical practice.

Study participation was voluntary. Each participant created a unique identifier (code) to allow for anonymized data analysis.

After the pilot phase we established a system of two facilitators for the discussion in plenum consisting of the expert and a general practitioner who moderates the discussion and asks the expert to give evidence-based answers.

Spinoff Online Cases

In the following months, participants could complete online cases and deepen their knowledge through individual study. The paper cases were transferred to our online learning system CASUS,[16,17] where participants could apply and test their knowledge. Eleven CME modules in endocrinology (eg, thyroid nodule, osteoporosis) and diabetes (diagnosis and treatment of diabetes mellitus) were offered. Each module comprises two to six short clinical cases. The design of the online cases requires an expenditure of 10 to 15 hours per topical unit. The courses were reviewed by a medical expert, a medical educator, and an expert on examination tools. The participants receive 2 to 3 CME credits for these short online cases each topical unit.

The core elements of the online cases reinforce material in the paper cases that were previously worked on in the seminar. The cases were supplemented with additional information and media.

Instruments

Two questionnaires with 46 items were used to evaluate the characteristics, computer skills, motivation, expectations, self-reported precourse knowledge, and validation of the CME course participants before and after the course using a Likert scale from 1 to 6 (1 = *strongly disagree* to 6 = *strongly agree*) and open questions. To evaluate the pre- and postcourse knowledge of the participants, 10 multiple-choice questions in a single best-answer format were asked before and after the course using an electronic voting system (MobiTED). The multiple-choice questions were written using evidence-based principles of item writing and were identical in the pre- and postcourse tests. We used Web server log file analysis to evaluate the participation and outcomes of the online course.

Participants

The total number of participants of the three courses (main study, July–November 2006) was 230; 165 physicians participated in at least one of the courses, 70.3% of them in one course, 20.0% in two courses, 9.7% in all three courses. The age of the participants ranged from 27 to 68 years, mean: 48.4 years (*SD:* 9.1). Of the physicians 56% were women, 44% men. The participants were mainly general practitioners and internists (60.3% vs. 22.7%) from Munich and the surrounding area (75.2% vs. 24.8%). The mean time since their specialization was 13.0 years (*SD:* 9.0); 12.6% were residents.

Results

Evaluation of Pre- and Postcourse Knowledge. In the precourse knowledge test, participants achieved a mean of 47.2% right answers and in the postcourse test a mean of 70.3% right answers, with an overall improvement in knowledge about the presented and discussed topics of 23.1% ($SD = 17.8$, $p < 0.001$).

Questionnaires. The precourse questionnaire was completed by 159 participants at their first visit. The participants who completed the questionnaires were mainly general practitioners and internists.

According to the evaluation of the precourse questionnaire, important reasons to participate were the interactive case discussion and the new design of the CME course. The participants expected practical guidelines for decision making, theoretical knowledge, and newest research findings. Their motivations to participate were based upon the relevance of the topics to their clinical work and the interactivity and team-based course format. They also stated they felt challenged to learn more about endocrinology and diabetes care and they enjoyed dealing with these topics. The physicians rated their own knowledge about the theoretical background and the diagnosis and therapy in endocrinology and diabetes care prior to the course as moderate (see TABLE 2).

In the postcourse questionnaire the participants considered the contents of the course to be appropriate for their

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TABLE 2. Precourse Questionnaire

						Likert Scale: Frequency (Percentage)					
	N	Min	Max	**Mean**	*SD*	1	2	3	4	5	6
Reasons to participate were . . .											
. . . topical focuses of the CME course.	152	2	6	**5.29**	.93	0 (0%)	1 (0.7%)	8 (5.3%)	20 (13.2%)	40 (26.3%)	83 (54.6%)
. . . the interactivity and team-based format.	148	1	6	**4.57**	1.41	6 (4.1%)	8 (5.4%)	16 (10.8%)	36 (24.3%)	30 (20.3%)	52 (35.1%)
. . . the selection of the experts.	146	1	6	**3.65**	1.60	21 (14.4%)	16 (11%)	23 (15.8%)	42 (28.8%)	21 (14.4%)	23 (15.8%)
. . . the time frame of the course.	142	1	6	**4.04**	1.57	14 (9.9%)	11 (7.7%)	22 (15.5%)	35 (24.6%)	28 (19.7%)	32 (22.5%)
Of this CME course I expect. . . .											
. . . a gain in theoretical knowledge.	154	1	6	**5.39**	.95	1 (0.6%)	2 (1.3%)	4 (2.6%)	17 (11.0%)	35 (22.7%)	95 (61.7%)
. . . practical guidelines for decision making.	153	1	6	**5.36**	.99	1 (0.7%)	3 (2.0%)	5 (3.3%)	14 (9.2%)	38 (24.8%)	92 (60.1%)
. . . the presentation of newest research findings.	153	1	6	**4.92**	1.20	1 (0.7%)	7 (4.6%)	12 (7.8%)	28 (18.3%)	41 (26.8%)	64 (41.8%)
. . . social contact with colleagues.	147	1	6	**3.35**	1.48	18 (12.2%)	29 (19.7%)	30 (20.4%)	38 (25.9%)	18 (12.2%)	14 (9.5%)
. . . to get to know a new design of CME course.	144	1	6	**3.28**	1.59	26 (18.1%)	23 (16.0%)	31 (21.5%)	28 (19.4%)	21 (14.6%)	15 (10.4%)
I am interested in the topics of the CME course.	153	1	6	**5.52**	.87	1 (0.7%)	1 (0.7%)	5 (3.3%)	8 (5.2%)	33 (21.6%)	105 (68.6%)
I enjoy dealing with topics on endocrinology/diabetes.	152	1	6	**5.36**	1.03	1 (0.7%)	1 (0.7%)	12 (7.9%)	10 (6.6%)	32 (21.1%)	96 (63.2%)
The topics of the CME course are highly relevant for my clinical work.	152	1	6	**5.28**	1.01	2 (1.3%)	0 (0%)	8 (5.3%)	18 (11.8%)	39 (25.7%)	85 (55.9%)
I would like to know more about the topics of the CME course than I know now.	150	1	6	**5.01**	1.20	2 (1.3%)	5 (3.3%)	12 (8.0%)	21 (14.0%)	41 (27.3%)	69 (46.0%)
Learning more about endocrinology/diabetes is a general challenge for me.	146	1	6	**4.75**	1.32	2 (1.4%)	8 (5.5%)	18 (12.3%)	27 (18.5%)	33 (22.6%)	58 (39.7%)
I rate my knowledge about the theoretical background of endocrinology/diabetes prior to the course as low.	145	1	6	**2.59**	1.13	17 (11.7%)	70 (48.3%)	27 (18.6%)	19 (13.1%)	11 (7.6%)	1 (0.7%)
I rate my knowledge about the management of patients with endocrine diseases or diabetes mellitus prior to the course as low.	143	1	6	**2.48**	1.23	28 (19.6%)	63 (44.1%)	21 (14.7%)	19 (13.3%)	10 (7.0%)	2 (1.4%)

Note: Likert scale 1 = *strongly disagree*, 6 = *strongly agree*. *N* = Number of participants who completed the questionnaire, Min = lowest rating, Max = highest rating, Mean = mean score, *SD* = standard deviation.

preknowledge and considered the course to be highly diversified and informative. They strongly agreed that the team-based case discussion enhanced thinking and learning and expected that the topics learned would affect their professional performance. Furthermore they appreciated the course in general and considered their expectations from the course to be fulfilled. The participants considered the guidelines and theoretical information provided sufficient (see TABLE 3).

Computer Skills and Online Cases. Of the participants 98.7% work with a computer (72.3% for private and business use, 20.1% business use only, 3.8% private use only). They spend a mean of 17.5 hours per week working with a computer (*SD:* 15.90). We also asked the participants about their activities with the computer: 86.2% stated to write texts, 58.5% to play computer games and to watch videos or look at pictures. In addition, 58.5% of the participants had already used the computer to work with educational software. They rated their own computer skills as moderate. After the CME course 63.1% of the physicians stated that they were interested in working on additional online cases.

The online cases have been available without charge to the participants of the pilot and main studies since February 2007. A total of 164 physicians were invited by mail to participate. The Web server log file analysis showed no significant use of the online cases until now (three participants). Therefore, we promoted the online CME modules again at the face-to-face CME courses. In future months the evaluation of the additional online CME course will show whether an interactive, team-based CME course can enhance long-term knowledge retention.

Discussion and Conclusion

An innovative and interactive design for a CME course with team-based learning was highly accepted by participating physicians. Almost a third of the 165 participating physicians participated in a series of CME courses. They rated the interactivity and case-based discussion as highly important reasons to participate. Their expectations to learn simultaneously more about practical guidelines for decision making and the newest findings in research appeared to be satisfied by the CME course design, which combines case-based learning with didactic lectures and intensive discussion with additional online cases. This conclusion was supported in the postcourse evaluations of the participants who stated that the CME course was very varied and informative and that the case discussions enhanced their thinking and learning. Their expectations, as expressed in the precourse questionnaire, were met for the majority of the participants. These outcomes are consistent with a study of Gerlach et al,[18] who found that physicians expect knowledge transfer with practical guidelines, opportunity for intensive discussion, imparting of the latest information, and case-based design from a high-quality CME course. The au-

TABLE 3. Postcourse Questionnaire

							Likert Scale: Frequency (Percentage)					
	N	Min	Max	**Mean**	*SD*	1	2	3	4	5	6
The contents were appropriate to my preknowledge.	95	1	6	**4.96**	1.23	2 (2.1%)	3 (3.2%)	7 (7.4%)	14 (14.7%)	28 (29.5%)	41 (43.2%)
The course was diversified.	95	2	6	**5.21**	1.01	0 (0%)	3 (3.2%)	5 (5.3%)	7 (7.4%)	34 (35.8%)	46 (48.4%)
The cases enhanced thinking and learning.	95	3	6	**5.46**	.75	0 (0%)	0 (0%)	4 (4.2%)	3 (3.2%)	33 (34.7%)	55 (57.9%)
I learned a lot in this course.	95	3	6	**5.16**	.84	0 (0%)	0 (0%)	4 (4.2%)	15 (15.8%)	38 (40.0%)	38 (40.0%)
What I learned will change my professional behavior and decisions.	93	1	6	**4.83**	.02	1 (1.1%)	2 (2.2%)	4 (4.3%)	23 (24.7%)	38 (40.9%)	25 (26.9%)
The course fulfilled my expectations.	94	2	6	**5.21**	.91	0 (0%)	2 (2.1%)	3 (3.2%)	10 (10.6%)	37 (39.4%)	42 (44.7%)
I expected more practical guidelines for decision making.	94	1	6	**2.60**	1.46	25 (26.6%)	28 (29.8%)	19 (20.2%)	9 (9.6%)	8 (8.5%)	5 (5.3%)
I expected more theoretical background information.	94	1	6	**2.42**	1.47	30 (31.6%)	31 (32.6%)	16 (16.8%)	6 (6.3%)	6 (6.3%)	6 (6.3%)
I enjoyed the course very much.	95	2	6	**5.37**	.96	0 (0%)	2 (2.1%)	4 (4.2%)	8 (8.4%)	24 (25.3%)	57 (60.0%)

Note: Likert scale: 1 = *strongly disagree*, 6 = *strongly agree.*

N = Number of participants who completed the questionnaire, Min = lowest rating, Max = highest rating, Mean = mean score, *SD* = standard deviation.

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Lessons for Practice

- Activation of CME course participants through group work (team-based learning) and interactive case discussions in the lecture hall leads to high acceptance and self-assessed gain of knowledge.
- The interactive course design leads to a significant increase in descriptive short-term knowledge.
- Participants claim to change their clinical practice after the course.

thors conclude that there is an explicit need for CME courses that enhance the exchange of knowledge through the activation of the physicians, cover relevant clinical topics, and facilitate a gain in knowledge and competence at the same time. Other studies have shown that physicians still prefer traditional didactic lectures as CME-course design, although numerous studies have shown their ineffectiveness.[19,20]

The present study shows that an interactive, case-based design of a CME course with team-based learning leads to a significant gain in the participants' knowledge with a previously identified preknowledge level. In their self-appraisal, the physicians learned a lot. Furthermore, they expected that the topics learned would influence their professional performance.

The physicians who participated in the current study had enough experience with computers and educational software to complete the e-learning activities. Nevertheless, they did not participate in the online cases provided, as the Web server log file analysis showed. Further incentives are needed to promote the use of the online cases. Maybe some participants do not work on online cases because the content of the online cases is similar to that of the cases of the CME course. Possibly we should provide a detailed introduction to the use of the Web-based modules, as Marmary and Charles recommend.[21]

Outlook

Further analysis of the processing of the online cases will show whether the gains in knowledge achieved in the CME course can be enhanced with additional online cases and whether the design of our CME course leads to more indelible knowledge retention. Additional studies are required to determine whether the CME course results in an objective performance change by comparing the participants' practice concerning prescriptions, diagnosis, and referral of patients before and after the course and compared to the practice of other physicians in the area.

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