Integrative Teaching in Radiology – A Survey

Integrative Lehre in der Radiologie – eine Bestandsaufnahme

Authors S. Dettmer[1], J. Weidemann[1], V. Fischer[2], F. K. Wacker[1]

German Association of Chairmen in Academic Radiology (KLR) G. Adam, G. Antoch, J. Barkhausen, M. Beer, T. Bley, A. Bücker, C. D. Claussen, C. Düber, M. Forsting, B. Hamm, K. Hauenstein, W. Heindel, N. Hosten, O. Jansen, T. Kahn, H. U. Kauczor, G. Krombach, C. Kuhl, M. Langer, M. Laniado, J. Lotz, A. Mahnken, D. Maintz, K. Nikolaou, M. Reiser, J. Ricke, E. Rummeny, H. Schild, S. Schönberg, R. P. Spielmann, C. Stroszczynski, U. Teichgräber, M. Uder, T. J. Vogl, F. Wacker

German Radiological Society (DRG) – Executive Board N. Hosten, M. Forsting, D. Vorwerk, F. Anton, J. Romahn, S. Lohwasser*

Affiliations
[1] Institute for Diagnostic and Interventional Radiology, Hannover Medical School, Hannover, Germany
[2] Dean's Office for Medical Education, Hannover Medical School, Hannover, Germany

Key words
- student teaching
- medical education
- radiological teaching
- integrative teaching

Abstract

Purpose: To survey integrative teaching in radiology at German universities.

Materials and Methods: A questionnaire about radiological education was sent electronically to all 37 chairpersons of university radiology departments in Germany. The questions included the course type, teaching methods, concept, perception, and advantages and disadvantages of integrative teaching. Statistical analysis was performed with nonparametric statistics and chi-square test.

Results: The survey was considered representative with a return rate of 68 %. Integrative teaching is established at 4/5 of all departments. Integrative teaching is well accepted with an acceptance rate that is significantly higher in so-called "Modellstudiengängen" [model courses of study] (100 %) compared to conventional courses of study (72 %). The advantages of integrative teaching include linking of content (92 %) and preparation for interdisciplinary work (76 %). The disadvantages include high effort (75 %) and time (67 %) for organization. Furthermore, there is a risk that basic radiological facts and knowledge cannot be conveyed and that the visibility of radiology as an independent discipline is lost. Conventional radiological teaching has a similarly high acceptance (84 %) compared to integrative courses (76 %).

Conclusion: Integrative teaching has a high acceptance among chairpersons in radiology in Germany despite the greater effort. A good interdisciplinary collaboration is essential for integrative teaching and at the same time this can be conveyed to the students. However, the visibility of radiology as a discipline and the possibility to cover basic radiological content must be ensured. Therefore, both conventional courses and integrative teaching seems reasonable, especially in cross-disciplinary subjects such as radiology.

Key Points
- Both integrative teaching and conventional radiological teaching are highly accepted. The advantages include the linking of multidisciplinary content and the preparation for interdisciplinary cooperation. The disadvantages include more time and effort for organization and reduced visibility of cross-disciplinary subjects.

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Correspondence
Dr. Sabine Dettmer
Institute for Diagnostic and Interventional Radiology, Hannover Medical School-Germany
Carl-Neuberg-Str. 1
30625 Hannover
Germany
Tel.: ++ 49/5 11/5 32 34 21
Fax: ++ 49/5 11/5 32 94 21
sabine-dettmer@t-online.de

Zusammenfassung

Ziel: Bestandsaufnahme der integrativen Lehre in der Radiologie in Deutschland.

Material und Methoden: An alle 37 radiologischen Lehrstuhlinhaber in Deutschland wurde elektronisch ein Fragebogen zur radiologischen Lehre verschickt. Unter anderem wurde die Art des Studiengangs, der Aufbau und die Zusammensetzung der Lehre, die Bedeutung integrativer und allein radiologischer Lehrveranstaltungen sowie die Vor- und Nachteile integrativer Lehre abgefragt. Die Auswertung erfolgte nicht parametrisch mittels deskriptiver Statistik und deren Gruppenvergleiche mittels Chi-Quadrat-Homogenitätstest.

Ergebnisse: Mit einer Rücklaufquote von 68 % ist die Umfrage als repräsentativ anzusehen. Integrative Lehre in der Radiologie wird an 4/5 der Fakultäten praktiziert. Die Akzeptanz integrativer Lehre ist sehr hoch, an Modellstudiengängen (100 %) signifikant höher als in Regelstudiengängen (72 %). Als Hauptvorteile integrativer Lehre wurden die Verknüpfung von Inhalten (92 %) und die Vorberei-

* DRG – Geschäftsführung

tung auf die interdisziplinäre Zusammenarbeit (76 %) genannt. Als Nachteile wurden der hohe organisatorische (75 %) und zeitliche (67 %) Aufwand angegeben. Zudem bestehe die Gefahr, dass grundlegende fachspezifische Inhalte nicht vermittelt werden können und die Sichtbarkeit des Faches verloren geht. Die Akzeptanz unter den radiologischen Lehrstuhlinhabern ist bei eigenständigen radiologischen Kursen (84 %) ähnlich hoch wie bei integrativen Lehrveranstaltungen (76 %).

Schlussfolgerung: Integrative Lehre hat trotz des hohen Aufwandes eine hohe Akzeptanz an den radiologischen Lehrstühlen in Deutschland. Eine gute interdisziplinäre Zusammenarbeit ist hierbei wichtig und wird den Studierenden gleichzeitig vermittelt. Jedoch sollten die Sichtbarkeit des Faches und die Möglichkeit zur Vermittlung grundlegender fachspezifischer Inhalte erhalten bleiben. Dafür ist es insbesondere bei Querschnittsfächern wie der Radiologie sinnvoll, neben integrativen Lehrveranstaltungen eigenständige Kurse anzubieten.

Introduction

Integration means “to create one unit” and “to become part of a larger whole ” [1]. The term integrative teaching has become established in human medicine for the collaborative teaching of different disciplines in on subject area [2]. Discipline-based division of content is not performed in favor of disease and organ-specific teaching. Instruction is performed in modules in which organ systems are taught in a multidisciplinary manner. Therefore, for example, the heart is taught in one module jointly by experts in anatomy, physiology, cardiology, cardiac surgery, radiology, and pathology. As a result, students are exposed to clinical content early on in their medical education and are taught in a practice-oriented manner.

Integrative teaching is suitable for radiology as a cross-disciplinary subject, in particular in connection with anatomy [3 – 6] and clinical disciplines in which imaging plays an important role, e. g. surgery and internal medicine [7]. Innovative radiological methods, such as multiplanar reformations, virtual endoscopy, functional and molecular approaches, and spectroscopy, result in new possibilities for including imaging in the teaching of fundamental disciplines such as anatomy and physiology and thus for implementing imaging early in medical education [8]. On the other hand, knowledge of anatomy is a requirement for information imparted in radiology [3]. On the whole, integrative teaching seems to better motivate students than conventional teaching with comparable or better learning success [9]. Computer-aided learning (e-learning) as a relatively new teaching method has become increasingly established in recent years [10]. In addition to time flexibility and individual learning speed, e-learning offers interactive and multimedia learning in terms of explorative and expositional learning strategies [11]. E-learning can support integrative teaching concepts of radiology and anatomy in that anatomical sections are linked with radiological imaging [12]. Despite all of the advantages of integrative teaching, it must be taken into consideration that it entails significant extra effort and thus increased costs [2] due to the close thematic and organizational coordination with the instructors of other disciplines and often due to the small group instruction. Medical education is regulated in the Licensing Regulations for Physicians [13]. Deviations are possible according to § 41 of the Licensing Regulations in the form of "Modellstudiengänge" [model courses of study] that have a time limitation and are approved under federal state law. These courses of study differ from classic conventional courses of study in that the strict separation between preclinical and clinical content is largely eliminated [14]. The first part of the medical examination can be eliminated, while the second part is retained. The goal of model courses of study is to more closely link theory and practice and to provide practice-oriented training. In this framework discipline-specific teaching is often dispensed with in favor of integrative organ-centered teaching in learning blocks or modules. Bedside teaching and problem-oriented learning are common methods. The manner and extent to which this is implemented differ greatly. Integrative teaching can also be practiced in conventional courses of study but the division between preclinical and clinical content is retained by the first part of the medical examination. Such conventional courses of study with reformed organization and a high percentage of integrative teaching are referred to as "reformed conventional courses of study" based on Putz [15] (**Fig. 1**). Integration of preclinical and clinical content is only possible to a limited degree in conventional courses of study in contrast to model courses of study due to the Student Capacity Law.

The first model course of study was created in 1999 at the Charité Berlin. At the time of our survey (summer semester 2013), model courses of study were offered at 9 of the 37 German universities with medical schools (Aachen, Berlin, Bochum, Hamburg, Hannover, Cologne, Mannheim, Oldenburg, and Witten/Herdecke), some with parallel conventional courses of study that are being phased out. In the winter semester 2013/14, Düsseldorf also began offering a model course of study. At the time of our survey, Bochum was offering both a conventional and model course of study. Students are now only accepted for the reformed course of study. Approximately 25 % of all new medical students are currently enrolled in a model course of study [16]. The German Council of Science and Humanities analyzed and evaluated the existing model courses of study in medicine and made recommendations regarding the further development of medical education on this basis. In these recently published recommendations, the German Council of Science and Humanities welcomed the transition from teaching based on the content of individual disciplines to competency-based education with the imparting of knowledge, skills, and attitudes [16]. Competency-based education is understood in this connection as the third generation of education concepts after problem-oriented, cross-disciplin-

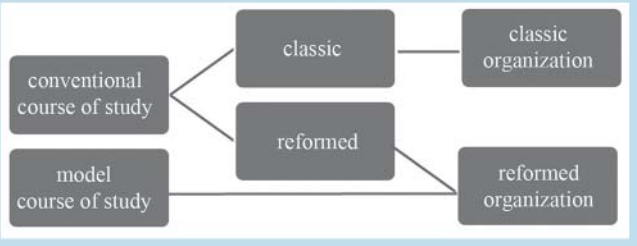

Fig. 1 Categorization of medical education into conventional and model course of study, classic and reformed conventional course of study, and reformed course of study.

ary, and discipline-based education. Discipline-based education is considered outdated around the world while organ-centered teaching is viewed as the standard [17].
Based on the general development at German universities toward more integrative learning concepts, the extent to which this has a fundamental effect on the teaching of students in radiology as a typical cross-disciplinary subject must be determined.

Materials and Methods

To determine the current state of radiology teaching in Germany particularly with regard to integrative teaching as well as the general acceptance and experience with new types of teaching, we performed a Germany-wide survey. The directors of the radiology departments at all 37 medical schools in Germany were contacted via email based on the network of the conference of chairpersons in radiology. In agreement with the survey participants, the questionnaire was not anonymous in order to allow queries. The questionnaire included four pages of questions regarding the following subject areas: Type of course of study, special teaching qualifications of colleagues, structure of the course of study (courses, academic year, type of course, integrative or not, required or elective course), importance of integrative courses and independent radiology courses, advantages and disadvantages of integrative teaching, teaching evaluation, performance-based allocation of funds, and prognosis for radiology teaching in the coming years (questionnaire as online supplement). Moreover, the use of e-learning was determined. This questionnaire only determined the structure of the courses of study at the individual medical schools. The teaching curricula were not examined.
Both open and closed questions including multiple choice questions and essay questions were used in the questionnaire. In the case of the multiple choice questions and Likert scale questions, multiple possible responses were summarized for the evaluation. Nonparametric evaluation was performed with descriptive statistics and by group comparisons via chi-square test (IBM SPSS Statistics, Vers. 20, San Jose, USA). The level of significance for the performed tests was 0.05.
A differentiation between conventional and model courses of study was made in the statistical evaluation. The universities offering both a conventional and model course of study at the time of the questionnaire were excluded from the separate evaluation. Based on Putz [15], a differentiation between classic and reformed conventional courses of study was made (**Table 1**, **Fig. 1**). Courses in a model course of study and a reformed conventional course of study were combined as reformed courses of study and differentiated from the classic conventional course of study.
Integrative teaching was defined as "teaching together with other disciplines". Since radiology teaching usually occurs together with the other radiation disciplines nuclear medicine and radiation therapy, integrative teaching with other disciplines, such as internal medicine, surgery, and anatomy, was included in the evaluation as "cross-disciplinary integrative teaching". The evaluation was performed solely on the basis of the information provided in the questionnaires or in a targeted query. The curricula of the individual universities were not evaluated.

Table 1 Universities with conventional and model courses of study in Germany at the time of the survey (2013). In the case of universities with a conventional course of study, a differentiation is made between classic organization and reformed organization based on Putz [15].

conventional course of study			model course of study
classic		reformed	
Bochum	Kiel	Dresden	Aachen
Bonn	Leipzig	Frankfurt	Berlin
Düsseldorf	Lübeck	Greifswald	Bochum
Erlangen	Magdeburg	Heidelberg	Hamburg
Essen	Mainz	LMU-München	Hannover
Freiburg	Marburg	Münster	Cologne
Gießen	TU-München	Tübingen	Mannheim
Halle	Regensburg	Göttingen	Oldenburg
Hamburg	Rostock		Witten/Herdecke
Homburg	Ulm		
Jena	Würzburg		
classic organization		reformed	

Results

From the 37 medical schools in Germany, 25 chairpersons in radiology or their lecturers (68 %) responded to our questionnaire. 18 (72 %) medical schools offered a conventional course of study and 5 (20 %) offered a model course of study. 2 medical schools (8 %) offered both a conventional and a model course of study at the time of the survey. Of the conventional courses of study, 11 (44 %) were classic and 14 (56 %) were reformed.
Most medical schools (84 %) had employees with special teaching qualifications. At one university (conventional course of study with classic teaching concept), one employee had a Master of Medical Education, the most comprehensive teaching qualification. Other teaching qualifications (courses lasting 1 – 3 days or more than 3 days) were very common. There were no employees with special teaching qualifications at only four universities (16 %), three of these had a conventional course of study including two classic and one reformed conventional course of study. Universities with a model course of study (61 %) had a tendency to have more employees with more comprehensive teaching qualifications (course duration of more than 3 days) than at universities with a conventional course of study (39 %). However, the difference was not statistically significant ($p = 0.966$). If the medical schools with a reformed course of study (in the framework of a model course of study or a reformed conventional course of study) are compared to those with a classic conventional course of study, they perform almost equally: 83 % of employees at medical schools with a reformed course of study had special teaching qualifications versus 82 % of those at schools with a classic conventional course of study. The percentage of employees with more comprehensive teaching qualifications (course duration of more than 3 days) at schools with a classic conventional course of study (36 %) was slightly lower than at schools with a reformed course of study (42 %). However, this was not statistically significant ($p = 0.442$).
80 % of those surveyed stated that they practiced integrative teaching, with 72 % in the case of a conventional course of study and 100 % in the case of a model course of study. In the integrative courses specified in our questionnaire, in-

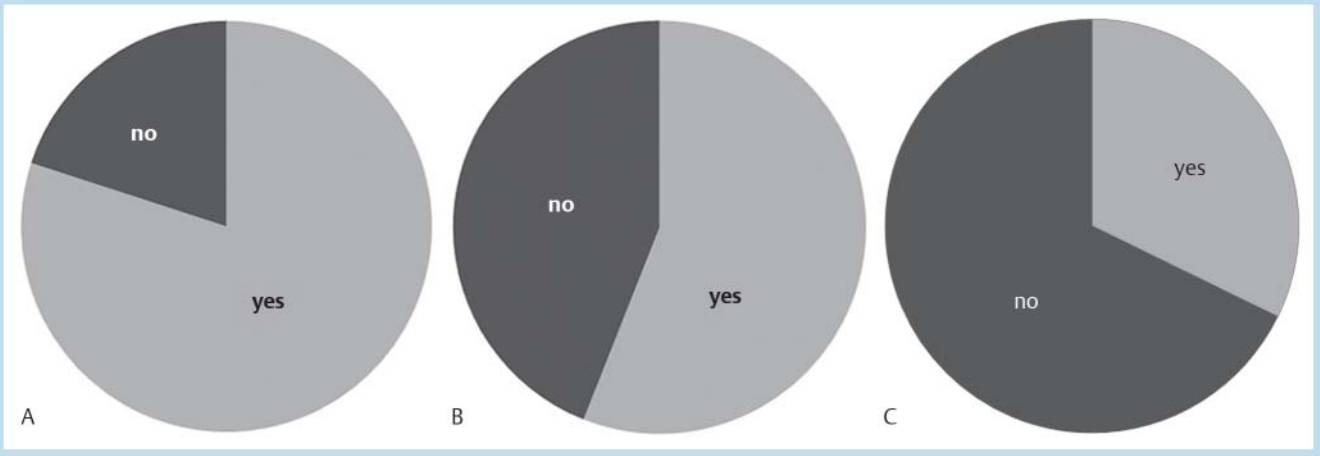

Fig. 2 Results of questionnaire regarding integrative teaching. **A** – offers integrative teaching, **B** – offers cross-discipline integrative teaching, **C** – instructors of both disciplines are present at integrative courses.

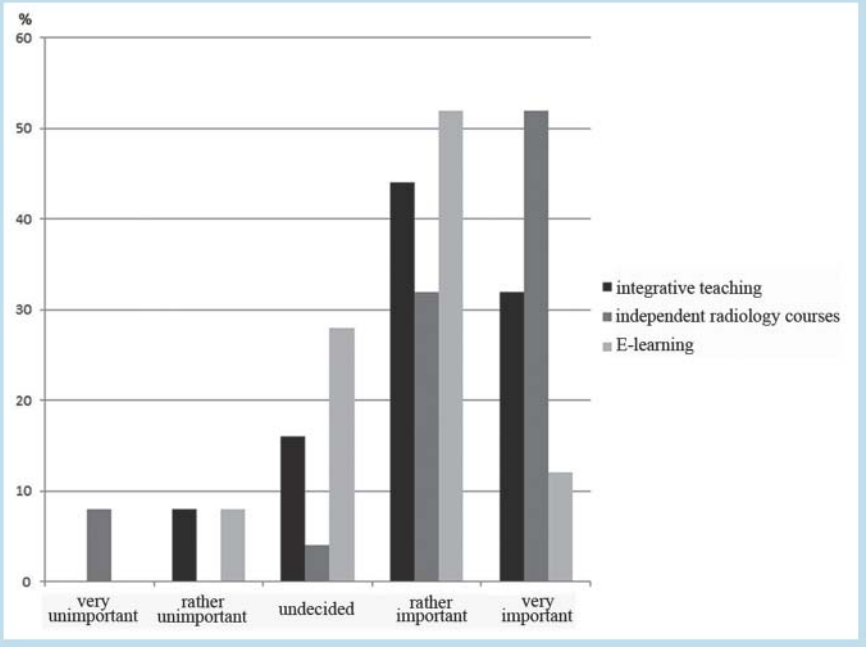

Fig. 3 Importance of integrative teaching, independent radiological teaching, and e-learning.

structors from both disciplines were present in only approximately 30 % of cases. Cross-disciplinary integrative teaching involving disciplines outside of radiology was practiced in only 56 % of the schools (conventional course of study: 44 %, model course of study: 80 %) (▶ **Fig. 2**).

19 (76 %) of those surveyed indicated that they find integrative courses important or very important, 4 (16 %) were undecided and 2 (8 %) found integrative teaching unimportant (▶ **Fig. 3**). The difference in relation to this question was significant ($p = 0.020$) between the schools with a conventional course of study (72 %) and a model course of study (100 %) and also between the schools with a reformed course of study (in the framework of a model course of study or a reformed conventional course of study) (100 %) and those with a classic conventional course of study (55 %) ($p = 0.016$). Of those who found integrative teaching important or very important, 13 (68 %) actually offered cross-disciplinary integrative teaching, while only 1 (16 %) of those who found integrative teaching unimportant or who were undecided offered cross-disciplinary integrative teaching ($p = 0.026$).

Independent radiology courses without participation of other disciplines were important or very important for 21 (84 %) of survey participants, 1 (4 %) participant was undecided, 2 (8 %) participants found the courses unimportant, and 1 person did not respond to this question (▶ **Fig. 3**). There were no significant differences between medical schools with a reformed or classic conventional course of study ($p = 0.557$) and between those with a model or conventional course of study ($p = 0.656$).

14 (56 %) of those surveyed stated that they would be happy to conduct more integrative teaching. 10 (71 %) of those who already offer integrative teaching with other disciplines wanted to offer more integrative teaching, while this number was only 4 (44 %) among those who do not offer integrative teaching with other disciplines ($p = 0.080$). There was no measurable difference ($p = 0.867$) between the uni-

versities with a conventional or model course of study and between those of a classic and reformed course of study (p = 0.327). 10 (40 %) of those surveyed stated that they did not want to increase the amount of integrative teaching because they already offer enough integrative teaching in 9 (36 %) cases and due to a lack of interest in 1 (4 %) case.

The linking of content was seen as a main advantage of integrative teaching (mentioned 23 times, 92 %). The preparation for interdisciplinary collaboration (mentioned 19 times, 76 %) and the early implementation of radiology in medical education (mentioned 17 times, 68 %) were also seen as advantageous (▶ **Fig. 4**). Preparation for interdisciplinary collaboration was mentioned as an advantage by the medical schools with a conventional course of study (72 %) significantly less frequently than by those with a model course of study (100 %) (p = 0.020). Higher motivation to learn on the part of the students was mentioned 13 times (52 %), with this being seen as significantly more important at schools with a reformed course of study (mentioned 10 times, 71 %) than at schools with a classic conventional course of study (mentioned 3 times, 27 %, p = 0.028). Performance-based allocation of funds (mentioned 2 times, 8 %) and knowledge of the fundamentals on the part of the students (mentioned 4 times, 16 %) were not important for the attractiveness of integrative teaching. With respect to opinions regarding the advantages of integrative teaching, there was no significant difference between the universities with a conventional and a reformed course of study except for in the case of the preparation for interdisciplinary collaboration. There was no significant difference in the evaluation of the advantages of integrative teaching between medical schools with a reformed course of study and those with a classic conventional course of study.

Primarily the high organizational (75 %) and time (67 % for the course and 54 % for the coordination of content) expenditure is stated as a disadvantage of integrative teaching. The risk of the content being too complex for the students was stated as a disadvantage by only 21 % of those surveyed (▶ **Fig. 5**). The high time expenditure for the course (conventional course of study: 56 %, model course of study: 100 %, p = 0.002), the significant organizational effort (conventional course of study: 67 %, model course of study: 100 %, p = 0.010) and the time-consuming coordination of content between instructors (conventional course of study: 39 %,

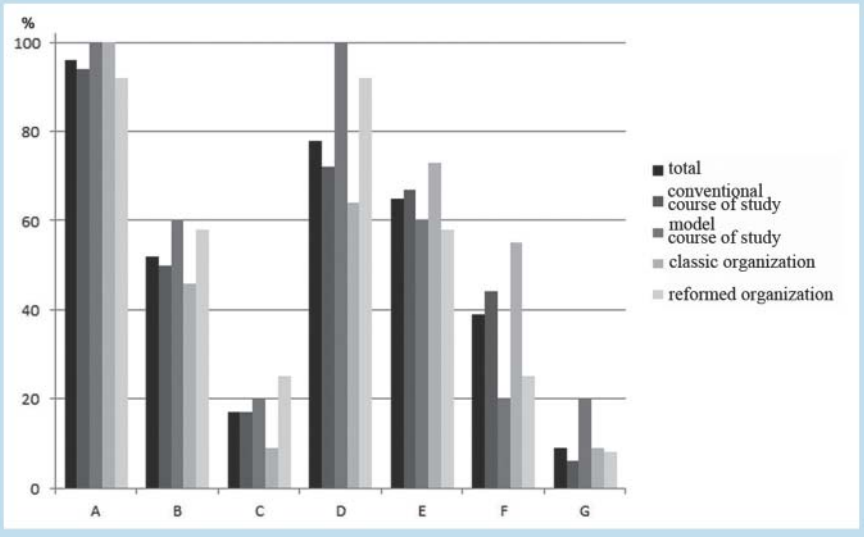

Fig. 4 Advantages of integrative teaching: **A** – easier learning due to linking of content, **B** – higher motivation to learn on the part of the students, **C** – knowledge of fundamentals on the part of the students, **D** – good preparation for interdisciplinary work, **E** – early implementation of radiology in medical education, **F** – better chances of recruiting new talent for radiology, **G** – allocation of additional funds for integrative teaching.

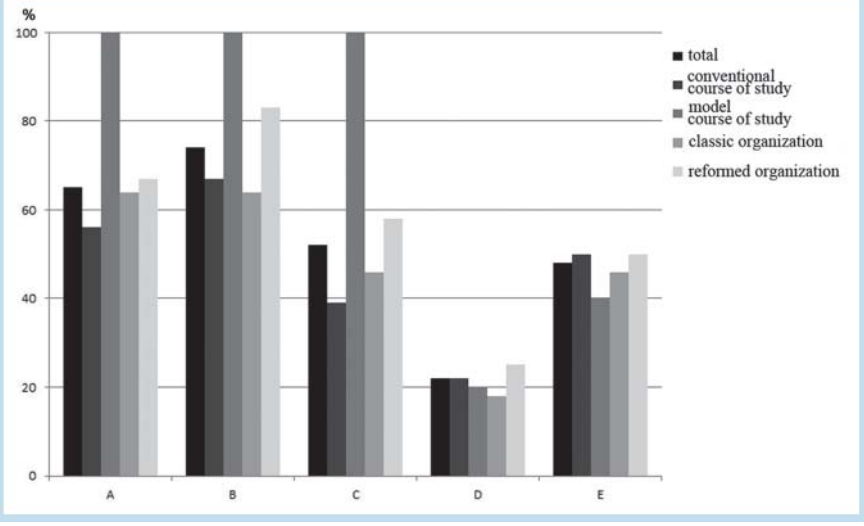

Fig. 5 Disadvantages of integrative teaching: **A** – higher time expenditure for courses, **B** – greater organizational effort (coordination of dates), **C** – time-consuming coordination of content between instructors, **D** – content too complex for students, **E** – lower visibility of radiology than in independent courses.

Table 2 In your opinion how will radiological teaching change in the coming years?

	much less	slightly less	same	slightly more	much more
percentage of integrative teaching	0 (0 %)	0 (0 %)	9 (38 %)	11 (46 %)	4 (17 %)
E-learning	0 (0 %)	0 (0 %)	2 (8 %)	11 (46 %)	11 (46 %)
semester hours	0 (0 %)	3 (13 %)	21 (88 %)	0 (0 %)	0 (0 %)
small group instruction	0 (0 %)	0 (0 %)	13 (54 %)	9 (38 %)	2 (8 %)
practical relevance	0 (0 %)	0 (0 %)	8 (33 %)	12 (50 %)	4 (17 %)

model course of study: 100 %, $p < 0.001$) were named by lecturers of the medical schools with a model course of study significantly more frequently as disadvantages than by those with a conventional course of study. All other responses did not show a significant difference between a model and conventional course of study. There was no significant difference between medical schools with a reformed course of study and those with a classic conventional course of study.

A teaching evaluation is performed at every university. This is performed centrally in the majority of cases (88 %) or more rarely by the own department (28 %), an outside department (4 %), or the students (4 %). There was no significant difference between the universities with a conventional and model course of study and those with a reformed and classic course of study.

In the majority of cases integrative and non-integrative courses were not evaluated separately (52 %). If a separate evaluation was performed, the result was either better (50 %) or equally good (50 %) for integrative teaching compared to conventional teaching. Integrative teaching did not rate worse in the evaluation by the students at any university regardless of the type of the course of study.

In the meantime, performance-based allocation of funds for teaching has become common. It is performed at 92 % of medical schools in total and 100 % of medical schools with a model course of study. Additional funds were typically allocated only for the own radiology courses (67 %), or less frequently for integrative courses under the guidance of non-radiological disciplines (21 %) or for publications, teaching qualifications, and third-party funds (25 %). There was no difference between schools with a conventional and a model course of study. At universities with a reformed course of study, performance-based allocation of funds was performed significantly more frequently for integrative courses under the guidance of other disciplines than at universities with a classic teaching concept ($p = 0.039$).

E-learning in radiology was offered at only 10 universities (43 %), while 64 % of those surveyed stated that they found e-learning to be important or very important. In most cases (64 %), e-learning was a voluntary program in addition to a course. E-learning was slightly more prevalent at medical schools with a model course of study (75 %) than at those with a conventional course of study (35 %), but this was not statistically significant ($p = 0.164$). Students usually had personal access and could therefore log in from home (73 %) The e-learning programs are typically created by the radiology departments and institutes (96 %) and the software is often an inhouse development (64 %). Open source software such as Ilias or Osirix (27 %) or commercial software such as Radbase or Riti (9 %) was used less frequently. The e-learning programs were typically purely radiological. There was only one integrative e-learning program together with anatomy.

In the prediction of the extent to which radiology teaching will change in upcoming years, the chairpersons of conventional and model courses of study and reformed and classic courses of study are largely in agreement (▶ **Table 2**). It is assumed that the percentage of integrative teaching, e-learning, and small group instruction will increase. Moreover, it was predicted that teaching will become more practice-oriented while the number of semester hours will not change substantially.

Discussion

25 of 37 chairpersons for radiology or their lecturers (68 %) responded to our questionnaire so that the survey is viewed as representative.

Integrative teaching in medicine has a long tradition [18]. Cross-disciplinary teaching has become increasingly established in recent years in model courses of study. This is also reflected in our questionnaire: 80 % of those surveyed stated that they practice integrative teaching. This is performed at 56 % of medical schools together with non-radiological disciplines such as internal medicine, surgery, and anatomy. Instructors from both disciplines were present at almost 30 % of integrative courses. These figures show that the term integrative teaching encompasses a number of different formats. Radiology, nuclear medicine, and radiation therapy are often traditionally taught together in one module but more or less in parallel and with separate content. The idea of the collaborative teaching of different disciplines with no thematic points of intersection regarding issues or organ systems is usually not implemented here. Therefore, we differentiated between radiological disciplines and other disciplines in the evaluation. In the case of integrative courses, e. g. in cross-disciplinary case discussions, it can be useful for instructors from both disciplines to be present at the same time. However, in the case of such collaborative courses, the organizational and personnel expenditure increases so that these courses are more difficult to implement and are not advisable for all teaching content. This is reflected in the results of our questionnaire: the expenditure for integrative teaching is categorized significantly higher than for other formats.

Integrative teaching in one module requires close thematic coordination. This means that a clinical picture or organ system is taught consecutively by different areas of specialization. The content is coordinated to facilitate the imparting of principles and to prevent repetition. The instructor accepts the role of an editor who is responsible for the overall concept of the course and its implementation. Since close collaboration with other disciplines is the rule for optimal patient care in the clinical routine particularly in cross-disciplinary subjects like radiology and this approach is to be conveyed to students, it is particularly important for radiology to also follow this interdisciplinary approach in teaching [19, 20]. Early implementation of radiology in medical

education, e. g. in anatomy class [3, 5, 6], and its consistent presence throughout medical education prepare students for the clinical reality as well as provide the opportunity to represent the discipline and thus to recruit new talent. According to the results of our questionnaire, the students in integrative courses are often more motivated, with this point being mentioned significantly more frequently by those offering cross-disciplinary integrative teaching than by those not offering cross-disciplinary integrative teaching.

The questionnaire results prove that performance-based allocation of funds does not tend to be an incentive for more integrative teaching. This could be related to the sum of performance-based funds available for teaching. In addition, radiology is often not the leading discipline in integrative courses and therefore receives no or only minimal funds for collaborative courses at many medical schools. It must be taken into consideration that the performance-based allocation of funds at different medical schools in Germany as well as internationally is performed according to very different criteria [21].

In the opinion of several authors, E-learning [overview in 10] is at least equal to conventional learning methods for continuing medical education as well as for student education [22, 23]. It is not yet comprehensively implemented in radiology teaching in Germany. Only 43 % of universities offer e-learning and usually not as a required course. Radiology is particularly suitable for e-learning [24, 25] since images can be analyzed and evaluated in a manner very similar to that of actual radiology. E-learning can be helpful not only in student education but also in radiology continuing education [11, 26] and in other professions in the healthcare industry [27]. Particularly with respect to the visual detection of a finding, the tempo of the students differs greatly and this can be better accommodated by the individual processing and learning tempo of e-learning than by a lecture [10, 28]. Another reason for the minimal usage could be the substantial effort needed for the initial setup of a module. However, this balances out if a module is used for a number of years with only small modifications or is used throughout the university. The Academy for Continuing Medical Education in Radiology offers online continuing education courses. The website "Die hellsten Köpfe" [Brightest Minds] [29] also offers its own platform for students. An adaptation of the e-learning programs to the currently discussed national catalog of learning objectives in radiology could further promote acceptance and broad usage.

There were some significant differences in the questionnaire results between the chairpersons of model courses of study, reformed courses of study, and classic conventional courses of study. Since there is no strict division between preclinical and clinical content in model courses of study, it is not surprising that the percentage of integrative courses is significantly higher and integrative teaching is more highly valued in these courses of study than in conventional courses of study. In contrast, the importance of independent radiology courses was evaluated similarly by representatives of both types of course of study. Chairpersons of model courses of study made significantly more comments regarding the advantages and particularly the disadvantages of integrative courses compared to chairpersons of conventional courses of study. Possibly the full extent of the additional organizational and personnel expenditure for integrative courses only becomes clear when integrative teaching is actually practiced. The National Competency-based Catalog of Learning Objectives was initiated in 2009 by the University Committee of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany based on the recommendations of the German Council of Science and Humanities from 2008 regarding quality improvement of teaching and academic studies in Germany in order to develop a sectoral qualifications framework for medical education [30]. A core curriculum for medical education is currently being created based on a joint decision by the Medical Faculty Association and the Society for Medical Education. According to our own data, this is intended to provide a means of orientation for medical schools but not to replace the mandatory study and examination regulations and the catalogs of learning objectives of the medical schools. A draft of the National Competency-based Catalog of Learning Objectives was published in the middle of 2013. Radiology content with an interdisciplinary design and thus an influence on many areas of specialization is not implemented in the National Competency-based Catalog of Learning Objectives. The professional societies should actively participate in the creation of adequate framework conditions for interdisciplinary and integrative teaching. Under consideration of symptom, disease, and patient-centered learning, the goal in radiology is not primarily to convey technical radiology knowledge but rather for students to learn so-called core competencies, i. e., the basic skills, necessary for practicing as a physician. This includes, for example, basic analysis of a classic X-ray and the selection of the correct diagnostic method for a specific issue as well as basic knowledge of radiation protection. Based on the present questionnaire in radiology and according to the plans for the National Competency-based Catalog of Learning Objectives, discipline-based teaching is becoming less important. Several studies have shown that this development increases practical skills but decreases understanding of fundamental sciences and formal understanding of disease processes [31, 32]. Points of criticism on the part of radiology disciplines regarding the current version of the National Competency-based Catalog of Learning Objectives are learning objectives that are too general, a lack of mandatory examination content, and underrepresentation of cross-disciplinary subjects [33]. Therefore, in a statement dated 11/15/2013 [33] the radiology disciplines fundamentally rejected the National Competency-based Catalog of Learning Objectives. In its "recommendations on the advancement of medical education in Germany", the German Council of Science and Humanities welcomes the increase in competency-based teaching with fundamental conveyance of knowledge, skills, and attitudes [16]. Competency orientation, integrated, patient-oriented curricula, strengthening of scientific competencies, interprofessional training, and focusing of course content are in the foreground. It is problematic in the survey and evaluation that there is a lack of established objective evaluation criteria and evaluation methods in medical education and the effects of certain teaching and examination formats in certain contexts remain unclear [16]. Therefore, there is a need for more research in this area. In general, the recommendations of the German Council of Science and Humani-

ties have been welcomed by the German Medical Association and the Medical Faculty Association [34].

If the effects of integrative teaching on cross-disciplinary subjects such as radiology are taken into consideration, more integrative teaching results in discipline-specific content being increasingly and at some medical schools exclusively taught in an interdisciplinary context in the framework of other courses or modules. The degree to which radiology is represented and is visible for students varies depending on the curriculum and concept of the leading discipline. If the cross-disciplinary subject is only involved as a partner with a few hours, it is barely visible for students. It is a challenge for radiology in this environment to convey sufficient basic knowledge regarding radiation physics, radiation protection, and technical principles of the different imaging methods. The systematic conveyance of the basic techniques of image analysis is barely possible. As a result, students lack the basic radiology know-how that every physician should have. A significant number of students specify this as the reason for taking an elective course in radiology. Moreover, there is a risk that the identity of cross-disciplinary subjects and the visibility of the disciplines for students will be lost and thus the number of people interested in corresponding continuing education will decrease. Despite all the advantages of integrative teaching, there is therefore a need and justification for independent radiology courses as our questionnaire shows. Moreover, in our opinion it is useful, particularly in model courses of study, to provide students with a "radiology roadmap" (in the sense of a discipline-specific study guide) that summarizes all radiology course offers or other equivalent areas of specialization and lists options.

A limitation of the present study is the lack of anonymization of the questionnaire. However, the evaluation was anonymous. Moreover, the questionnaires only determined the structure of the courses of study at the individual schools. The teaching curricula were not examined. However, these are typically not publicly available and if they are they are often not up-to-date. An exact analysis of the implementation of radiology teaching in the total curriculum in particular in combination with the basic disciplines would be interesting, e. g. to better explain missing knowledge of the fundamentals on the part of the students. Moreover, the effects of integrative teaching on the students were not determined. Therefore, it would be interesting to examine the extent to which an integrative teaching style effects the radiology knowledge of the students, whether the visibility of radiology for the students changes, and whether this has an influence on professional choices and later professional life. This should be the subject of subsequent studies.

Conclusion

Despite the high time and personnel expenditure, integrative teaching is highly accepted by chairpersons in radiology. The linking of content and the preparation for interdisciplinary collaboration are valued above all because they facilitate the learning process and better represent the later clinical activity. Despite all of the advantages, we feel that the visibility of the discipline and the ability to convey fundamental discipline-specific content must continue to be ensured. Therefore, it is reasonable, particularly for cross-disciplinary subjects such as radiology, to offer integrative as well as independent courses. The increased organizational and personnel expenditure of interdisciplinary courses for the involved disciplines should be better taken into consideration in performance-based allocation of funds.

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