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Experiences with different integration strategies of case-based e-learning

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Abstract

Background: E-Learning applications are part and parcel of modern medical curricula. Despite this increasing use, the empirical basis for an optimal integration strategy of computerized teaching methods is small for medical education. In addition to general aspects of integrating e-learning into a curriculum, like feasibility, software and content requirements or curriculum structure, the integration strategy is crucial.

Methods: In this article different integration strategies of e-learning are presented and compared with respect to motivational aspects and acceptance of both, students and instructors.

Results and Conclusions: As best practice we recommend a voluntary integration strategy combined with exam-relevance of the content. The assets and drawbacks of all described strategies are discussed in the conclusions of this article.

Background

E-Learning applications are an indispensable component of modern medical curricula. It has been shown that people learn more efficiently or faster (Lyon et al. 1992) by using e-learning applications under certain conditions and demonstrate better knowledge retention (Greenhalgh 2001; Clark 2002; Ruiz et al. 2006). However, the evidence base for best practice guidelines for an appropriate integration of computerized teaching methods in medical education is small (Fischer 2003; Grunwald & Corsbie-Massay 2006).

To our knowledge this is the first study describing and comparing different integration strategies of case-based learning in medicine.

Aims

The aim of our study is not to justify the use of e-learning applications as such, but to compare different strategies for the integration of e-learning and to derive best practices. The mode of integration has been highlighted by Friedman as a major challenge among researchers when comparing the computer with other media, usage patterns and assessment methods (Friedman 1994). Cook states that the integration of a computer-based learning (CBL) tool into the curriculum is as important as the optimization of the software itself (Cook 2005).

In this paper, we describe and compare different implementation strategies of case-based learning as an important component of e-learning.

Practice points

- Motivate students positively.
- Keep in mind how the learning objectives of each e-learning unit contribute toward the overall concept of the curriculum.
- Provide sufficient technical and professional support to students and faculty.
- Ensure that exams cover the learning objectives embedded in the e-learning units.

Methods

Since 1999 online cases have been integrated into the medical curriculum at the University of Munich (LMU) in different settings. This study compares five different integration strategies implemented since then and presents the relevant evidence.

We compare the different integration modalities concerning:

- Advantages and disadvantages for learners and tutors in general
- Acceptance of students as determined by case use and evaluation results
- Average time spent working on a screen card as an indicator for diligence
- Effort required of tutors to implement an online course

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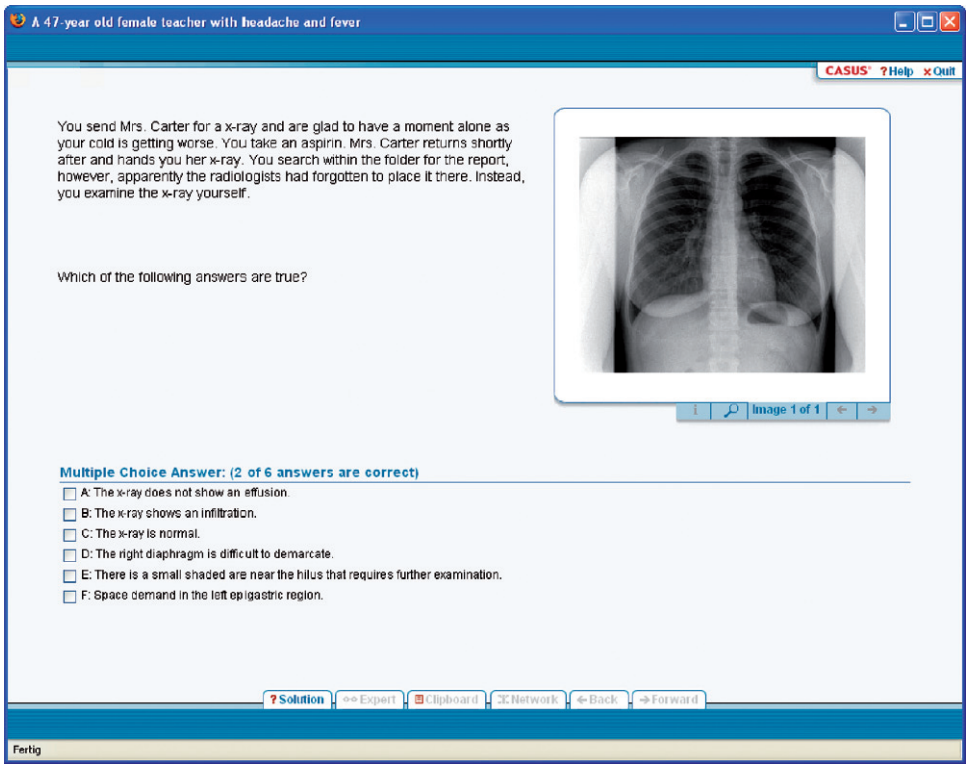

Figure 1. CASUS screencard (Player).

It was a prerequisite for all of our investigations to use CASUS, a dedicated case-based software with high accessibility, an integrated user evaluation system, easy-to-use case-creation and learning capabilities. The content delivered was relevant, peer-reviewed and covered the learning objectives of the curriculum (Childs et al. 2005; Fall et al. 2005).

CASUS learning system

CASUS is a software package for authoring and delivering case-based learning based on a pedagogical concept developed by the AG Medizinische Lernprogramme at the LMU since 1993 (Fischer et al. 1996; Fischer 2000). CASUS has been well integrated into the curricula at different institutes in paediatrics, internal medicine, surgery, occupational medicine and medical psychology (Simonsohn & Fischer 2004; Fall et al. 2005).

What is a CASUS case?

A medical CASUS learning case usually presents the story of a real patient history organized in didactic units with findings and management. This approach reflects established clinical practice. About 5 (short case) to 25 (long case) screen cards (see Figure 1) form a learning case. Each card represents a variable combination of text elements with hyperlinks, multimedia material, expert comments for additional information and most importantly interactive elements such as different question types with immediate evaluation of student responses and a detailed answer comment. If enabled by the course instructor, students can contact the case author via asynchronous communication and discuss questions and problems they encountered while working through the cases. At the end of each case an online questionnaire pops up to enable students to evaluate the case.

The relevant quantitative data such as number and duration of case sessions (i.e. time spent working on a case), and time spent on a screen card were collected by analysing the database entries and log files. As an indirect indicator for diligence we used the average time the user spent on a card.

The correct answers given by the students have not been considered for the comparison due to differences in the nature of questions.

From the online questionnaires we considered the comments given by the students as well as the questions described in the learning by teaching strategy. All other questions are not consistent throughout the analysed settings with regard to scale, question focus and formulation and therefore were not comparable.

The response rate is based on the total number of case sessions.

The data collected for this study has been treated in accordance with the data protection law.

The implementation approaches of our study are described in the following section (see also Table 1).

Providing a self-contained case collection as a voluntary learning unit. In 2004 e-learning cases were provided on a voluntary base in addition to the lecture. Students who completed the cases did not get any additional credit.

Every student ($n = 239$) was given online access to 10 cases matching the curricular objectives in internal medicine. This was announced at the beginning of the term and students were reminded periodically by instructors to use the cases.

Table 1. Criteria for integrating online cases into the curriculum in different settings.

Concept criterion	Voluntary cases (strategy 1)	Obligatory cases (strategy 2)	Learning By Teaching (LBT) (strategy 3)	Exam relevant cases (strategy 4)	Combination of strategy 1 and 4 (strategy 5)
Learner role	Learner	Learner	Author	Learner	Learner
Incentives to participate	None	Credit	Credit, gaining in-depth knowledge of an issue	Preparation for exam	Preparation for exam and seminar
Communication between teachers and learners	None	Asynchronous communication tools	Asynchronous communication tools, regular seminars	Asynchronous communication tools	Asynchronous communication tools
Teachers role	None	Support	Support	Support	Support
Level of integration with face to face teaching	In addition to lectures, seminar	In addition to lectures, seminar	Integrated in a seminar	In addition to lectures, seminar	In addition to lectures integrated in seminar

Providing mandatory cases which have to be completed in order to succeed in the overall course ("mandatory strategy"). At the Institute and Outpatient Clinic of Occupational Medicine (OM) and Environmental Medicine at the LMU, the undergraduate course consists of a weekly lecture, mandatory tutorials and online cases matching the curricula objectives in OM.

To complete this course successfully, students have to attend the tutorial, complete at least two of 10 provided online cases successfully and pass the written exam at the end of term (Radon et al. 2006). The established minimum requirements to pass the cases were at least 50% correct answers, session duration of at least 20 minutes and 100% completed screen cards within each case.

Self registration by the students was required for enrolment in the course.

Learning by teaching (LBT). Since 2003, a LBT-project, initialized by the Chair for comparative law at the LMU Munich and the Virtual University Bavaria, has been successfully integrated into the curriculum of three law schools in Germany (Holzer et al. 2003). Learners create cases for their fellow students under the guidance of experts.

Students register themselves for a seminar (up to 12/term). The topics and learning objectives of the cases are chosen by the tutors and sample cases to work through before starting on the main case creation are provided.

A total number of 105 participants in small groups (2–3/group) created cases in a tutorial setting and each received credit for the completed case, which was also reviewed by an expert. Some of the reviewed and revised cases are integrated into the curriculum as learning cases.

Providing voluntary e-learning cases and motivating students by announcing exam relevance of the content ("exam strategy"). In summer 2005, two cases about lung and heart auscultation were made available to all students of the internal medicine module ($n = 225$) three weeks before the final exams. These were contained in Objective structured clinical examinations (OSCE) and a paper-based multiple-choice (MC) exam. Working on the cases was voluntary. However, it was announced, that they would be relevant for the OSCE exam at the end of the term. One of the 12 stations was implemented as an online key feature exam with CASUS, based on the two cases presented during preparation.

Combined strategy. Since 2005 the integration concept of online cases in internal medicine at the LMU Munich combines motivation through exam relevance and supplementing PBL tutorials and seminars with cases matching curricular learning objectives. The cases used are the same cases used in the integration concept described in Section 1.

Each term, about 225 students are provided 15 online cases, which are relevant for the final MC exam. About 10% of the questions are related to the cases. In addition to the lecture, students have to attend a weekly seminar and are required to prepare for the lecture with a self-study online case matching the topic of the seminar. In this course, the online case and several paper cases are discussed. In addition, students have the possibility to contact the case author to discuss particular problems.

Students cohorts were different in each of the described approaches; but they all were 3rd year medical students, except for the LBT-strategy, in which 2nd to 4th year law students participated.

Results

In the following, the five integration concepts for online cases as examples will be outlined and compared.

Providing a self-contained case collection without any external motivation. The acceptance of students in this setting was very low. Only 21 of the 239 students (=8.8%) worked on one or more cases. 14 students completed one case; only one worked through all cases (=0.4%). (see Figure 2). The average time spent on a screen card was 1.4 minutes. 15 online questionnaires were completed: the total number of sessions was 45 and the response rate 33.3%.

The statement "Tutorial support was sufficient" was rated with an average of 4.4 on a six-point Likert type scale in which 1="strongly agree" and 6="strongly disagree". This poor result shows that an integration concept is indispensable to enhance acceptance and motivation of students. Although the effort of managing such a voluntary course is minimal, the outcome is very unsatisfactory.

Providing mandatory cases which have to be completed in order to succeed in the overall course. In the summer term 2005, 93.6% of 234 students completed the two required cases successfully. The outcome of this course is quite promising;

129 students (55.1%) worked on more than the two cases and more than 16% completed all cases (see Figure 2 for details). The average time each student spent on a screen card was 1.3 minutes. 343 online questionnaires have been completed (33.2% response rate), but the questions as well as the comments are solely related to the case content.

The responsible course tutors have to set thresholds for passing the course with respect to time on task, performance, and completeness of case sessions. Although the course administration tool of CASUS provides an automatic report for each course, the time-consuming task for tutors is to process individual student requests concerning pass-fail decisions. Students who failed the course are given the chance to complete the required cases afterwards, which also results in additional effort for tutors.

Learning by teaching. A total of 44 cases were created by 105 students in 27 groups of two and 17 groups of three.

The time spent on creating one case is on average 54 hours per student, but with a wide range (20–200 hours).

The online evaluation, with a 24-items questionnaire ($n = 53$, response rate = 50.5%), shows a positive and highly motivated attitude of the students towards this teaching approach.

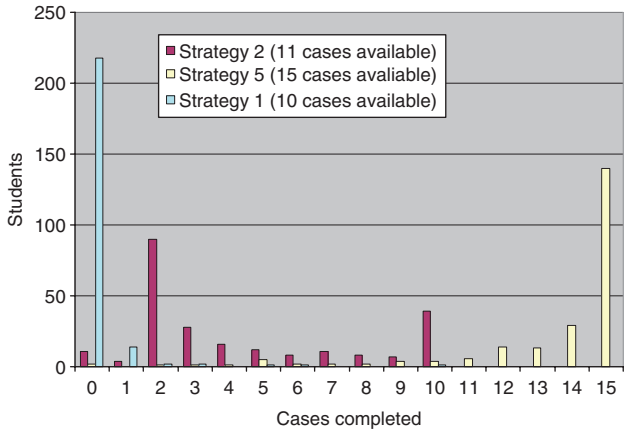

Figure 2. Completed cases in occupational medicine ($n = 234$, strategy 2), internal medicine ($n = 225$, strategy 5 and $n = 239$, strategy 1).

As expected, the motivation of the students to participate in this seminar (90%) is attributable to the credit they received at the end of the term, but they also gave other reasons for participating in the seminar. 67% of the students cited interest in case-based training and effectiveness of LBT as reasons for their participation.

A quantitative survey of the responsible tutors showed that the time and effort for implementing this seminar was significantly higher than in all other described settings. The overall estimated support effort from tutors during the case creation process was approximately 15 hours/student which included instructions on technical and conceptual aspects. Moreover, the reviewing and revising process turned out to be very time-consuming, resulting in an average time of about 10 hours for reviewing each case and about 50 hours for the revising process.

In addition to that, the tutors emphasised that careful preparation of the tutorial is important. For an optimal result, a detailed description about the topic of their case and case learning objectives has to be provided. Moreover, students have to be carefully instructed about technical and didactic aspects of case creation.

Teaching cases as preparation for (online) exams. In the summer of 2005, 204 of 225 students (= 90.7%) completed both cases provided with 1.8% completing one case. The average time spent on a screen card was 1.7 minutes. The time and effort for the tutor to implement this kind of integration concept is significantly lower than in the settings described earlier whereas the success and response rate are almost as high. Though there was no need to analyse case sessions, it is very important to design the final exam appropriately and include questions relating to the provided cases. The numbers of case sessions done by students accelerates as they approach the exam day and it is notable that even on the day of the exam, about 80 students worked on a case (Figure 3).

271 questionnaires were completed (response-rate = 65.8%). The statement "Tutorial support was sufficient" was rated an average of 3.4 on a six-point Likert scale

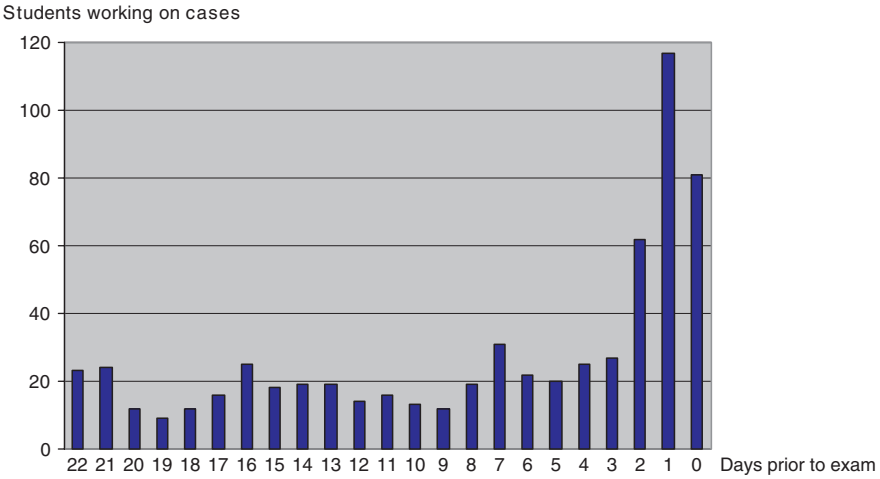

Figure 3. Number of students per day working on a case prior to the exam.

(1 = strongly agree, 6 = strongly disagree). 22 of 62 comments are related to wanting more information in addition to the cases.

Combined concept. During winter term 2005/06 62% of the 226 students completed all 15 cases of the course, 91% completed 10 or more cases (Figure 2).

The average time spent on a screen card was 2.3 minutes. We found that student motivation to complete cases was very strong when integrated with tutors expressing explicit exam relevance of the cases plus PBL courses or seminars emphasising case relevance, as opposed to strictly voluntary use which was found to be disappointing.

The questionnaire was completed 597 times (response rate = 19.5%).

The comments made by the students are mainly related to the content of the cases, only 8 students suggested that the interaction of the weekly seminars and the cases could be improved.

Summary

The following table reviews the above discussed integration strategies concerning effort from tutors and the acceptance of learners based on our experiences.

Conclusions

The results of the voluntary integration strategy show that an integration concept is indispensable if one wants students to work on the provided cases. These findings are corroborated with respect to voluntary use of cases by various earlier studies (Lyon et al. 1998; Baumlin et al. 2000) and have been also found in 1999 at the LMU (Simonsohn & Fischer 2004).

Regardless of whichever integration concept is implemented in a curriculum, there are several important aspects which have to be considered. The software should be easy-to-use, highly accessible and should support user evaluation (McKimm et al. 2003; Cook & Dupras 2004). The content delivered must be relevant, peer-reviewed and cover the learning objectives of the curriculum (Childs et al. 2005; Fall et al. 2005). User support and case maintenance are essential. These aspects have been prerequisites for all implemented strategies.

Tutor effort

Feasibility plays a major role when integrating e-learning into the curriculum. One needs to consider how many experienced instructors are available to manage the extra effort as well as the adequacy of the technical infrastructure at the faculty (Greenhalgh 2001; Childs et al. 2005). In addition to case maintenance and user support which is mandatory for integration strategies, the LBT-strategy as well as the obligatory integration require additional instructor effort (see Table 2). Integrating online cases with a LBT strategy is only feasible if competent tutors are available who can manage the course as well as review and revise the cases. Compared to the other settings only a small number of students can participate in such seminars given the required faculty support efforts.

When using the "exam-relevance argument" (strategies 4 and 5) to motivate students to work on the cases, the final exam has to be designed appropriately. Regardless of the type of exam, a significant number of questions and topics covered in the cases must be included. However the administrative time and effort is lower than that required for a mandatory integration. In this approach, there is no need to control success or to control and prevent cheating, as learners do not gain from exchanging correct answers or clicking through the cases without ever carefully reading the content.

Using the "exam strategy", the tutorial support was rated as insufficient and many students wanted more information in addition to the cases. This might indicate a need for an improved embedding of the cases into the overall course such as realised in combined strategy. Unfortunately we have no similar question for the combined strategy to compare this with.

To check whether students worked on the cases using the combined integration strategy, instructors can check the results of the case sessions, and/or ideally test the knowledge of their students, about the required case in their face-to-face seminar. The latter might be a drawback for some instructors because of the extra time needed to work through the cases themselves when preparing for their seminar.

Case use

The percentage of used cases was highest in the mandatory strategy; but taking into account that only two completed cases were required, 16% completed all cases vs. 62% in the combined strategy and 90% in the "exam strategy". An interesting research question could be to compare the results when implementing "the mandatory strategy" with the requirement that the students complete all cases. But because OM is a small subject compared to internal medicine it is difficult to give students enough extra time to complete 8 more cases. Providing adequate study time is an important aspect when integrating e-learning modules (Cook & Dupras 2004).

Comparing the case use of the voluntary and mandatory setting shows an interesting difference. In voluntary setting 8.8% completed one or more cases, 0.4% completed all. In the mandatory setting 54.7% went on to look at more than the required cases and 16% completed all of them, although they did not get any credit for the additional cases. This is a surprising difference, which will be a matter of further evaluation.

Another future research study will focus on the combined integration strategy, to further evaluate the interaction between cases and seminars, especially focusing on whether tutors refer to the cases in their seminar as suggested. One research aim in particular, is to find out whether the case use can be improved by improving the interaction.

Although one could consider making cases obligatory to increase student usage, given our success (90.6% completion of cases) found in the approach using teaching cases as preparation for exams, such a heavy-handed, externally applied motivation may reduce the fertile opportunities for

Table 2. Qualitative summary of the results: Comparison of the discussed integration concepts concerning effort, cases completed, time spent on a card and other aspects.

	Voluntary (1)	Obligatory (2)	LBT (3)	Exam-relevant (4)	Combination (5)
Time/card	1.4 minutes	1.3 minutes	not known	1.7 minutes	2.3 minutes
Acceptance	8.8% completed one of 11 cases	93.6% completed the two required cases, 16% completed all 10 cases	all students completed case creation	90.7% completed both cases, 1.8% one case	62% completed 15 cases, 91% 10 or more cases
Effort for tutor	Choose relevant cases, case maintenance	Choose relevant cases, evaluation of case sessions, case maintenance	Prepare case learning objectives, reviewing/revising cases, introduce and support case creation	Choose relevant cases, case maintenance, exam design	Choose relevant cases, case maintenance, exam design
User support					
Other aspects		Prevent cheating, handle borderline and failed case sessions	Limited number of participants due to intensive support		

self-motivation to master the learning objectives. This aspect is a matter of considerable discussion (Eisenberger et al. 1999).

Time spent on a card

Our experience with the different implementation settings led to a combination of two strategies as described in Section 5, using exam-relevance and the supplementation of a PBL course as motivating factors. Comparing the time spent on card results in students spending more time working on a card (average of 2.3 minutes) with this intervention compared to other implementation strategies. However, the time spent on a screen card is only a very rough indicator of the thoroughness of a case session and can be influenced by external factors such as speed of the internet connection, parallel studying of textbooks and other interruptions during the work time. Although we believe these factors do not significantly influence our findings, a further evaluation should be implemented, taking these factors into account. For optimal preconditions all strategies should be implemented with the same cases (which was done only in the voluntary and combined strategy), but this is difficult to realise.

Compared to the concept of motivating through exam relevance alone, the combined strategy facilitates regular work on the cases without having a major increase in case sessions just before the exam. This fact, as well as using the blended learning approach with discussion of the case content in a tutorial setting, could indicate more effective learning with longer knowledge retention. Difficult as it is, measuring retention is an important evaluation topic for future research.

Limitations and future research

For the integration concept LBT described in strategy 3, the cohort was of law students and not medical students. A similar integration concept will be implemented with medical students in their final year in 2007 at the LMU Munich. In contrast to the law students, these students have been exposed to online cases throughout their studies. We will compare their results with the described setting with special focus on the tutor effort to revise the cases.

All presented strategies have been evaluated separately and using different online questionnaires, but they need to be seen in the context of the overall curriculum. Explicit questions aiming at the integration strategy have to be included in further research since evaluation might be influenced by multiple factors such as the overall course concept, related face-to-face teaching formats, or the relevance of the covered topics.

As recommended by Cook (2005) CBL should be used when it appears to be most effective and research should focus on when to use it. With regard to the rising number of online-cases integrated into the medical curriculum, an important research aspect will be to evaluate whether there is a maximum number of online cases which should be integrated in a curriculum in relation to other teaching material and how the number of cases influences the acceptance of students.

Conclusions for successful integration of e-learning

- Motivate your students positively by getting them to participate in interactive seminars and case development; communicate to them working through the cases contributes to success in the course and possibly in their future practice of medicine.
- Consider the effort tutors need to support a case-based course and whether this is feasible.
- Ensure that exams cover the learning objectives embedded in cases.
- Consider future research on curricular integration of cases in conjunction with face-to-face teaching.

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HAROLD C. LYON, PhD, Fulbright Senior Specialist, Dartmouth Medical School and Notre Dame College, USA and kindly revised this paper.

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