ORIGINAL ARTICLE

Case-based e-learning to improve the attitude of medical students towards occupational health, a randomised controlled trial

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ABSTRACT

Objectives Undergraduate medical teaching in occupational health (OH) is a challenge in universities around the world. Case-based e-learning with an attractive clinical context could improve the attitude of medical students towards OH. The study question is whether case-based e-learning for medical students is more effective in improving knowledge, satisfaction and a positive attitude towards OH than non-case-based textbook learning.

Methods Participants, 141 second year medical students, were randomised to either case-based e-learning or text-based learning. Outcome measures were knowledge, satisfaction and attitude towards OH, measured at baseline, directly after the intervention, after 1 week and at 3-month follow-up.

Results Of the 141 participants, 130 (92%) completed the questionnaires at short-term follow-up and 41 (29%) at 3-month follow-up. At short-term follow-up, intervention and control groups did not show a significant difference in knowledge nor satisfaction but attitude towards OH was significantly more negative in the intervention group ($F=4.041$, $p=0.047$). At 3-month follow-up, there were no significant differences between intervention and control groups for knowledge, satisfaction and attitude.

Conclusions We found a significant decrease in favourable attitude during the internship in the experimental group compared with the control group. There were no significant differences in knowledge or satisfaction between case-based e-learning and text-based learning. The attitude towards OH should be further investigated as an outcome of educational programmes.

What this paper adds

- Occupational health is not a very popular medical specialism among medical students.
- Various educational formats have been tried to improve the knowledge of medical students and their attitude towards occupational health but little is known about their efficacy.
- In our study, case-based e-learning did not improve the attitude of second year medical students towards occupational health when compared with non-case-based textbook learning.
- Attitude towards occupational health is a valuable outcome measure in addition to the more common learning outcome measures knowledge, skills and performance.

INTRODUCTION

Undergraduate medical teaching in occupational health (OH) is a challenge in many universities around the world.[1–4] A future career as an OH physician is not popular among medical students. Some of the reasons for this attitude are that OH is considered to be far apart from clinical practice, that it involves many administrative tasks and that it does not appeal to the diagnostic and other core skills of physicians.[5 6] Various formats of OH teaching programmes have been introduced to improve teaching and to tailor programmes to students' perceived learning needs and preferences.[1–3 7] Students especially rated case scenarios or case-based learning as helpful in general and more helpful than workplace visits.[2 8]

Evidence is available that internet-based learning has large effects on knowledge outcomes, skills and learner's behaviour when compared with no intervention but similar effects when it is compared with non-internet instructional methods.[9] Raupach *et al*[10] reported virtual collaborative learning to be as effective as problem-based learning sessions in the acquisition of reasoning skills in fourth year medical students. However, e-learning could increase the interest of medical students by maximising the use of clinical relevance.[11] We hypothesised that presenting cases would thus favourably influence students' attitude towards OH.

Evidence about students' satisfaction with e-learning is contradictory. In the meta-analysis of Cook *et al*,[9] internet-based learning had no significant effect on satisfaction compared with non-internet formats. Carroll *et al*[12] stated that the use of real-world cases are well perceived by doctors in the UK. On the other hand, Raupach reported web-based learning to be less acceptable than traditional problem-based learning in fourth year medical students. Burgess *et al*[13] stated that postgraduate students prefer core-teaching material to remain in the printing medium with online practical exercises as supplement.

Knowledge, skills and satisfaction are regular outcome measures in medical education research.[14]

The effect of education on the attitude and views of medical students towards a specific medical content or profession is less well studied. Attitude towards OH represents views, perceptions and preconceived opinions of students about OH and OH physicians.[15] A positive attitude may reinforce the learning efforts of the students, which is vital in the learning process.[16]

Therefore, case-based e-learning, with an attractive and relevant clinical context, might be a means to stimulate the interest of medical students in OH and thus to improve their rather negative attitude towards the specialty of OH and a future career as an OH physician.

Therefore, the research question of this study is: Is case-based e-learning compared with traditional text-based learning more effective in improving knowledge, satisfaction or a positive attitude towards OH in second year medical students than non case-based textbook learning?

METHODS

Study design

In 2008 and 2009, we conducted a randomised controlled trial.

Participants

Participants were second year medical students at the Academic Medical Center in Amsterdam, the Netherlands, who received their first formal education about OH during their medical studies.

Intervention and control groups

Students were randomly assigned to an intervention group and a control group by means of a random number table created in Excel that was matched to a list of students that were registered for the course. The even numbers were assigned to the intervention group.

After a short introduction about the research project, the group was split up in the intervention and the control groups. All students in the intervention group elaborated three occupational medicine e-learning cases on individual computers. The topics of the e-learning cases were maternity protection, hepatitis B in a medical student and occupational asthma. These cases are designed by the NeTWoRM group (Netbased Training for Work-Related Medicine) and suitable for medical students.[7] The control group received written material about the same topics, which they could read. This written material consisted of photocopies of pages of an Occupational Medicine textbook, practice guideline material and scientific articles. The number of pages was adjusted to the available time.

For both groups, learning was scheduled for half a day and formed the start of a junior internship of 1 week. All students worked in a classroom without further guidance or control. In addition to learning about occupational diseases, the objective of the internship was to learn the basics of occupational history taking and to get to know OH practice through 3 days of actual practice visits with an occupational physician. The students knew that they would be tested, but they knew also that there were no pass/fail criteria.

Measures

We used three different measures to evaluate the outcome of the educational process: a questionnaire about attitude towards OH, one about knowledge of OH and one about satisfaction. The participants completed the questionnaires at the start of day 1 as baseline measurement, directly after the total intervention, at the end of the junior internship at day 5 and after 3-month follow-up.

The attitude part consisted of 15 questions. To answer the questions a 5-point Likert scale was used with anchors ranging from disagree to agree. The total questionnaire thus could yield a minimum score of 15 and a maximum score of 75, with 75 indicating a maximal positive attitude. Knowledge consisted of 20 questions, divided in multiple-choice, open-ended and true/false questions. The scores are presented as percentages of correctly answered questions. Satisfaction was measured with nine questions: one was a general rating for satisfaction (range 1–10), five questions about satisfaction with the course content (5-point Likert scale, minimum score 5, maximum 25) and three questions about satisfaction with learning (5-point Likert scale, minimum score 3, maximum 15).

To prevent recall bias, we developed three different but comparable versions of the attitude and knowledge questionnaires. Participants received these different versions in random order at the first three measurement moments so that in the end each participant had answered all three versions. The use of these questionnaires was balanced within both groups. The same satisfaction questionnaire was used at the three follow-up times. For the measurement after 3-month follow-up, all participants received the same questionnaire.

Statistical analyses

The data were entered into a database without the researcher knowing to which group the participant belonged. Data were analysed using Statistical Package for Social Sciences (SPSS) V.16. Checking the three versions of the questionnaires with one-way analysis of variance revealed that one version of the knowledge questionnaire had lower scores than the other versions. We calculated the effect of the intervention on knowledge by calculating the mean percentage or mean number of correct answers per questionnaire. Next, we used the general linear model for repeated measures to test if there were effects of time, group and an interaction of time and group on the mean percentage or mean number of correct answers. To adjust for differences in the knowledge questionnaire versions, we included the baseline scores of knowledge as covariates in the analyses. We used Mauchly's Test of Sphericity to test for sphericity. If Mauchly's test was significantly different, the assumption of sphericity was rejected and the corrected Greenhouse–Geisser value was utilised. For attitude, we summed up all items that indicated an attitude favourable towards OH and we followed the same analytical procedure as for the knowledge test. For the three questions where the statement implicated a negative attitude towards occupational medicine, we reversed the score so that the total score indicates a total favourable attitude towards occupational medicine.

To make up for missing values, we used imputation by carrying forward the last observation to the measurement of the junior internship week. We checked if the responders at day 5 were different from the non-responders, which they were not. Therefore, we assumed that the missing values were not systematically different and could be imputed by the last observation carried forward. We decided that there were too many missing values at the follow-up measurement 3 months after the junior internship week to make a reasonable estimation, so no imputation was done for this measurement. A p value <0.05 is taken as cut-off value for statistical significance.

RESULTS

There were 141 students who were eligible, and all could be randomised to the intervention or the control group and 128

completed all questionnaires at baseline. One hundred and thirty students (92%) completed the questionnaires at the end of the educational programme on day 1: 64 in the intervention group and 66 in the control group. At the end of day 5, 124 students completed the questionnaires: 61 in the intervention group and 63 in the control group. It was more difficult to get questionnaires back at 3-month follow-up. Only 41 students (29%) completed all four questionnaires: 18 in the intervention group and 23 in the control group.

The baseline characteristics of the students are described in table 1. There were no significant or relevant differences in age or gender between the intervention and the control groups at baseline. About the characteristics of the group that responded at follow-up (3 months), there were no significant differences between responders (n=41) and non-responders (n=100) at follow-up regarding age, sex and attitude score at baseline. Knowledge score differed significantly at baseline between responders and non-responders (p=0.011), with responders having a higher score.

At the first three measurement times, significant time effects were present for attitude (F=8.9, p=0.001) decreasing over time and for satisfaction increasing over time (general satisfaction F=5.3 (p=0.023); content satisfaction F=59.6 (p<0.001); learning satisfaction F=8.3 (p=0.005)). There was also a significant interaction effect of time and group for attitude (F=4.0, p=0.047), meaning that there was a significant decrease of attitude in the intervention group compared with the control group. In table 2, the crude mean scores of the two groups are shown at follow-up directly after the intervention and at day 5 at the end of the course.

There were no significant interaction effects of time and group for knowledge (F=0.7; p=0.42) and satisfaction (general satisfaction F=0.01 (p=0.94); content satisfaction F=0.03 (p=0.86); learning satisfaction F=0.3 (p=0.58)), meaning that there were no significant differences between both groups at any of these measurement times for knowledge and satisfaction.

For the group of 41 participants that completed the questionnaires after 3-month follow-up (table 3), there were no significant interaction effects between group and time meaning that there were no differences between intervention and control groups in outcome at the four measurement times. In table 3, the mean scores at all measurement times are shown for the subgroup that could be followed for 3 months.

DISCUSSION

We compared the effects of case-based e-learning as a stand-alone option, offered in the classroom in a second year OH junior internship, to text-based learning under similar conditions. There was a significant decrease in favourable attitude during the internship in the experimental group compared with the control group immediately after the internship. There were no significant differences between experimental and control group for knowledge and satisfaction at any point of follow-up.

Table 1 Baseline characteristics of participants (N=141)

Characteristics	Intervention	Control
Age in years, mean (SD) (N_i=71, N_c=70)	21 (1.7)	21 (1.9)
Women, n (%) (N_i=71, N_c=70)	49 (69.0)	51 (72.9)
Mean attitude at baseline (SD) (N_i=63, N_c=64)	49.8 (5.2)	51.1 (5.3)
Mean % knowledge at baseline (SD) (N_i=64, N_c=64)	52.4 (10.2)	53.1 (9.9)

N_c, number of participants in the control group; N_i, number of participants in the intervention group.

Table 2 Total scores of the intervention and control groups directly after the intervention and at day 5

Topic	Mean total scores (SD)	
	Intervention	Control
Attitude (N_i=63, N_c=64), maximum score 75		
Directly after the intervention	49.0 (5.9)	50.5 (4.4)
At day 5	47.1 (8.4)	49.4 (5.8)*
Knowledge (N_i=64, N_c=64), maximum score 100%		
Directly after the intervention	53.4 (10.4)	54.6 (10.0)
At day 5	53.1 (9.1)	54.2 (8.1)†
Satisfaction general rating (N_i=64, N_c=66), maximum score 10		
Directly after the intervention	6.2 (1.2)	6.3 (1.2)
At day 5	6.5 (1.0)	6.5 (1.3)‡
Satisfaction with course content (N_i=63, N_c=63), maximum score 25		
Directly after the intervention	16.7 (2.9)	16.8 (2.5)
At day 5	18.9 (2.3)	18.7 (2.4)§
Satisfaction about learning (N_i=63, N_c=63), maximum score 15		
Directly after the intervention	9.5 (2.3)	9.7 (2.0)
At day 5	10.1 (2.2)	10.2 (2.2)¶

*Repeated measures interaction time and group: F=4.0, p=0.047.
†Repeated measures interaction time and group: F=0.7, p=0.42.
‡Repeated measures interaction time and group: F=0.01, p=0.94.
§Repeated measures interaction time and group: F=0.03, p=0.86.
¶Repeated measures interaction time and group: F=0.3, p=0.58.
N_c, number of participants in the control group; N_i, number of participants in the intervention group.

One of the strengths of our study is the randomised controlled design. Thus, we could prevent selection bias in the sense that students who are more attracted to one of the teaching methods would have a possibility to influence this choice. Another strong point is that, to our knowledge, this is the first study that used attitude towards OH as an outcome measure in addition to the more common learning outcome measures knowledge, skills and performance.

A limitation of the study is that this was a rather short, one morning only, educational programme, and the effect of the programme should not be overestimated. In addition, the educational programme was embedded in a longer junior internship that could have had a more powerful effect on attitude at longer follow-up. If there would have been an effect of case-based e-learning, this should have been apparent immediately after the first educational session at day 1. Unfortunately, we could only measure the outcome at longer term in a small subsample of students. Despite repeatedly requests by mail, we were not able to increase the response. Students were apparently busy with other assignments in their study and not motivated to complete our questionnaires. It is clear that the outcomes in this subsample can be biased by the attrition of participants. These results should therefore be interpreted with great caution. Another limitation is that the questionnaire with which we measured attitude towards OH had only face validity and we cannot say which differences are meaningful in a practical sense. In advance, we did not expect differences in knowledge. But we did expect a positive effect on satisfaction and attitude and that the sample size would be sufficient to detect such a difference.

In this study, we found a significant short-term negative effect of the intervention on the attitude towards OH at the measurement at the end of the OH junior internship week. The differences are small, and the question is whether this difference between the e-learning group and the text-based group is relevant. The decrease of attitude towards OH is apparent directly after the intervention. The junior internship does not change this development. Intriguing is the decrease of the attitude scores for both groups during the junior internship. An

Table 3 Total scores of the intervention and control groups at baseline, directly after intervention, at day 5 and after 3 months

Topic	Mean total scores (SD)	
	Intervention	Control
Attitude (N_i=17, N_c=23), maximum score 75		
At baseline	50.1 (5.0)	52.2 (4.6)
Directly after the intervention	49.8 (5.8)	51.0 (5.0)
At day 5	48.8 (6.7)	50.3 (5.1)
After 3-month follow-up	46.9 (5.3)	45.5 (8.3)*
Knowledge (N_i=18, N_c=23), maximum score 100%		
At baseline	56.7 (11.2)	54.3 (10.0)
Directly after the intervention	52.8 (9.4)	56.2 (11.1)
At day 5	52.6 (8.2)	55.8 (6.9)
After 3-month follow-up (T3)	50.0 (8.4)	49.1 (9.8)†
Satisfaction general rating (N_i=17, N_c=22), maximum score 10		
At baseline	NA	NA
Directly after the intervention	6.6 (1.3)	6.1 (1.0)
At day 5	6.4 (1.2)	6.2 (1.3)
After 3-month follow-up	6.5 (1.4)	6.2 (0.8)‡
Satisfaction with course content (N_i=18, N_c=23), maximum score 25		
At baseline	NA	NA
Directly after the intervention	16.3 (3.4)	16.8 (2.6)
At day 5	19.2 (2.8)	18.7 (2.3)
After 3-month follow-up	17.7 (3.1)	18.7 (3.5)§
Satisfaction about learning (N_i=18, N_c=23), maximum score 15		
At baseline	NA	NA
Directly after the intervention	9.7 (2.7)	9.4 (2.1)
At day 5	9.8 (2.6)	10.4 (2.4)
After 3-month follow-up	9.7 (2.5)	9.6 (2.2)¶

*Repeated measures interaction time and group: F=2.7, p=0.107.
†Repeated measures interaction time and group: F=0.13, p=0.722.
‡Repeated measures interaction time and group: F=5.8, p=0.451.
§Repeated measures interaction time and group: F=2.2, p=0.146.
¶Repeated measures interaction time and group: F=0.18, p=0.673.
NA, not applicable; N_c, number of participants in the control group; N_i, number of participants in the intervention group.

explanation for this could be that second year students are rather naive towards OH and that the students are focused on clinical problems and clinical specialties in a hospital setting.[5 6] After the educational programme and the occupational medicine internship, they have learnt that occupational medicine is different from clinical specialties and therefore they develop a less favourable attitude towards occupational medicine. And maybe the students expected to be exposed to more cases in the internship, after receiving some elaborated cases at the start? Another consideration is that the attitudes of medical students towards various specialties change during the study. Students could be more open towards a non-clinical specialty, and an educational programme on occupational medicine could thus be more effective in a later stage of the study when students have a more varied clinical experience. At that stage, occupational medicine could become a medical field of their choice.

Our results are similar to those of Diachun *et al*,[17] who studied the effect of education in geriatrics. They report a 'worsened attitude' of students towards older adults after a geriatric clerkship and conclude that this might be because geriatrics is regarded as a non-essential discipline in medical education. A comparable conclusion is drawn for Canadian students' perceptions of public health.[18]

This study found that an e-learning format resulted in similar changes in knowledge and satisfaction as a non-internet-based text-based learning format in medical students.[9] We offered the e-learning in the classroom, and therefore, we did not make use of one of the advantages of e-learning which is that it can be implemented independent of time and place. It has been argued that a blended approach, combining e-learning formats with other face-to-face formats, is more effective than e-learning as a stand-alone option.[19] In addition, a strong educational context, and 'exam-relevance of the e-learning content', has been advocated.[20] In future research, it should be studied if internet-based formats work better under these conditions.[9 21] The attitude towards OH should be further investigated as an outcome of educational programmes.

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