

Research-Tutored Learning: An Effective Way for Students to Benefit Research by Critical Appraisal

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Abstract

Introduction: Medical students must be able to read and critically appraise scientific papers. Therefore, they have to be taught specific skills. There is evidence from a range of studies that research-tutored learning is an effective way to achieve this. We examined the learning gain and opinion of students exposed to research-tutored education. **Methods:** Two hundred fifty-five medical students from the Leiden University Medical Center reviewed the quality of 144 randomized controlled trials appearing as references in 59 advertisements published in both an independent scientific and a commercial medical journal. We examined the subjective learning gain and critical appraisal skills of students by a questionnaire. **Results:** The assessments of references showed that in both a commercial and an independent medical journal 70-80% of included references scored suboptimal. The opinion of students about this course was positive. Furthermore, after being exposed to research-tutored learning, students rated their critical appraisal skills as having improved (3.86 mean, SD 0.88 on a scale of one to five). They also indicated an understanding of the importance of reading literature during their career. **Conclusions:** Exposing students to research-tutored learning is an effective way to develop additional skills concerning reading and critical appraisal of scientific papers.

Introduction

Medical information comes from many sources, including advertisements in medical journals from pharmaceutical companies. These advertisements are an important source of information for general practitioners.¹ However, it has been shown that many claims in such advertisements are not sufficiently evidence-based when the cited references are verified.²⁻⁸ It is therefore essential that medical students learn to judge the presented information and separate reliable from non-reliable advertisements. In addition, they should be able to communicate and discuss this information with colleagues. Consequently, medical students must be able to read and critically appraise scientific papers and be able to present their own scientific findings. All this requires a specific additional set of skills.

Healey suggests that research-tutored learning which focuses on writing and discussing papers or essays, is one of the most effective ways to develop this additional set of skills.⁹ There is clear evidence for this from a range of studies that evaluate learning in a research-tutored environment.¹⁰ Hence, students are likely to gain most benefit from research, in depth of learning and understanding, if they participate in research activities.¹¹ Students experiencing research feel that they gain intellectuality, are exposed to professional socialization, gain technical and communication skills, and are more certain in their educational and career plans.¹² This is illustrated by the fact that students participating in the 'research' Scholarly Concentration at the USF Health Morsani College of Medicine, showed a concordance of 70% between the chosen area of research and the choice of residency.¹³ However, it remains unclear whether research-tutored learning also affects self-efficacy with respect to critical appraisal skills of students.

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In this study we aim to examine students' satisfaction and perceived learning outcomes of our new approach to research-tutored learning. We focus on self-efficacy, the measure of one's own ability to complete tasks and reach goals. For medical students it is not enough to have the knowledge and the skills to perform a task, they must also have the conviction that they can successfully perform it. According to Bandura, self-efficacy beliefs lie at the core of human functioning.¹⁴ Additionally, it has been shown that self-efficacy has a direct positive effect on performance in specific medical contexts.¹⁵ We

therefore examined the impact of research-tutored learning in a cohort of 255 pre-clinical medical students of Leiden University, the Netherlands. During the research-tutored teaching program, medical students reviewed the quality of randomized controlled trials (RCTs) appearing as references in advertisements in both an independent scientific and a commercial medical journal. Afterwards, the opinion of the students about research-tutored learning and their perceived learning outcomes was examined by a questionnaire.

	H&W* (n=69)	MM† (n=44)	Difference [95% CI]
Mean reference validity score	13.34	14.36	-1.03 [-2.02 to -0.41]
Mean question score‡			
1) Was a method of randomization performed?	1.98	1.96	0.02 [-0.04 to 0.08]
2) Was the treatment allocation concealed?	1.16	1.26	0.10 [-0.29 to 0.08]
3) Were the groups similar at baseline regarding the most important prognostic indicators?	1.75	1.83	-0.08 [-0.21 to 0.04]
4) Were eligibility criteria specified?	1.83	1.91	-0.08 [-0.02 to 0.04]
5) Was the outcome assessor blinded?	1.04	1.30	-0.26 [-0.48 to -0.04]
6) Was the care provider blinded?	1.21	1.46	-0.25 [-0.53 to 0.03]
7) Was the patient blinded?	1.32	1.62	-0.29 [-0.59 to 0.01]
8) Were point estimates and measures of variability presented for the primary outcome measures?	1.47	1.49	-0.02 [-0.23 to 0.19]
9) Did the analysis include an intention-to-treat analysis?	1.57	1.53	0.03 [-0.18 to 0.25]

Table 1: The validity of RCT references in advertisements of H&W compared to MM as scored by 255 medical students. *H&W = *Huisarts en Wetenschap*. †MM = *Modern Medicine*. ‡Questions based on the Delphi list.¹⁴ The answer options 'yes', 'don't know', and 'no' were assigned question scores of 2, 1, and 0 point(s) respectively.

Methods

In the Leiden University Medical Center (LUMC), 255 second year medical students are required to enroll in the course Scientific Education. The course focuses on several specific scientific skills and forms the foundation for scientific thinking and acting in the LUMC medical curriculum. It offers training in different study-designs and the basics of statistical data analysis. During this course, we have exposed students to research-tutored learning. To this end the students reviewed the quality of RCTs appearing as references in advertisements in both an independent scientific and a commercial medical journal.

These advertisements were collected from two Dutch journals aimed at general practitioners: *Huisarts en Wetenschap*, and *Modern Medicine*, because the content of these journals is relatively well understood by second year medical students. From the available journals aimed at general practitioners, we chose two journals with a large printing run. Therefore, these journals have a high impact on prescribing behavior in the Netherlands. *Huisarts en Wetenschap* (ISSN 0018-7070) is the official journal of the Dutch College for General Practitioners (NHG) published by Springer Publishers. The goal of the NHG is to support evidence-based patient care. *Huisarts en Wetenschap* is a peer reviewed, scientific journal.¹⁶

Modern Medicine (Dutch edition, ISSN 0929-0141) is published by Van Zuiden Communications, and it is freely distributed among all Dutch general practitioners. Its goal is to inform the reader about the latest developments in patient care in an accessible manner.¹⁷ Because of its goal and because it is not peer reviewed it is considered to be a commercial journal.

All drug-promoting advertisements that appeared in these journals were copied: *Huisarts en Wetenschap*, January to December 2005; and *Modern Medicine*, January to December 2007. From all advertisements, the listed references were obtained using PubMed (<http://www.ncbi.nlm.nih.gov/pubmed/>). This database was chosen because both students and general practitioners use this database most frequently and since this database is most extensive and up to date. We chose to specifically study RCTs, since they provide a high level of evidence and are highly prevalent in pharmaceutical advertisements.

Each student reviewed the quality of two RCTs. These were independently assigned to each student and students were blinded for the origin of their references. In order to promote critical appraisal of the reference and minimize inter-observer variation the students used a standardized score form containing nine questions. They received a manual with exact guidelines on how to score every question, based on the Delphi list (see Table 1 for the questions contained in the score form).¹⁸ The students were trained to use this score form during a one-hour theoretical lecture. During this lecture issues concerning the reliability of RCTs, such as randomization, treatment allocation, and blinding were discussed. The students also reviewed and discussed a non-related RCT as an exercise in critical appraisal in a small group setting. Additionally, all students had to present both of their critically appraised RCTs in a group meeting with colleagues and a supervisor of the department of Communication in Science. This ensured that students took their assignments seriously. Before this time, the conventions, rules and principles underlying an effective presentation in an academic setting were introduced, and individual feedback on a student's own performance was provided. In this manner a presentation skills training was integrated into the course. Finally, open-ended questions were included in the score form, requesting an explanation of the reasoning behind the chosen answer. Students were required to fill out their score forms in order to receive their course end mark.

Score form questions could be answered by (a) *yes*, (b) *don't know*, or (c) *no*. *Yes* denoted the presence of the desired characteristic, *don't know* indicated mentioning of the characteristic with lack of specification, and *no* denoted the characteristic to be absent or not mentioned. *Yes*, *don't know*, and *no* were assigned scores of two, one, and zero point(s) respectively.

Each reference was planned to be evaluated by four different students. A mean question score was then calculated per question, per reference. For every reference a 'reference validity score' was calculated, that is the sum of the mean question scores of all nine questions for a single reference (range zero to 18 points). We considered a study suboptimal if the mean reference validity score was below 16 points.¹⁹ In this case, more than three out of nine questions were scored suboptimal, or more than one question was scored with no points at all and a second question was scored suboptimal.

Score forms were submitted via the internet using a web design interface and were automatically entered into an SPSS database (version 16.0) for statistical analysis (IBM Corporation, Armonk, NY). When the difference between the highest and lowest reference validity score was more than five points, the most deviant result was deleted from the database. When the database contained less than three evaluations of a single reference, a panel of four experienced students reassessed it. Every RCT reference was grouped into one of the following drug categories: (a) cardiovascular, (b) pulmonary, (c) diabetic, and (d) other (Table 2).

In order to assess the effect of this specific type of research-tutored education, all 255 students were asked to fill out a questionnaire in which a scoring system of one to five was used. One represented total disagreement with the given statement and five represented total agreement. The questionnaire was designed to give insight in the students' satisfaction with regard to the course and to collect the students' self-assessment data. The students were asked amongst others about how valuable the course was for their intellectual and learning process, if the course was challenging, and if they had learned to read articles more critically (Table 3, see Appendix).

Drug category	Total		<i>Huisarts en Wetenschap</i> alone		<i>Modern Medicine</i> Alone		Both	
	N	Score	N	Score	N	Score	N	Score
Cardiovascular	45	14.36	14	14.82	13	14.89	18	13.62
Pulmonary	24	13.90	7	14.82	13	13.98	4	12.00
Diabetic	27	12.14	22	12.06	5	12.50	-	-
Other	48	14.10	26	13.21	13	14.94	9	15.43
Total	144	13.78	69	13.34	44	14.36	31	13.93

Table 2: Mean reference validity scores* by drug category

*Mean reference validity scores calculated from separate reference validity scores based on the questions as shown in Table 1.

Results

To gain insight in the students' satisfaction with the course and to collect self-assessment data, we analyzed the outcome of the questionnaire (Table 3). Results show that the research-tutored learning gain as implemented in our course was rated positive (3.14 mean, SD 0.86). The learning curve was rated with a mean of 3.07 (SD 0.86). Students reported their presentation skills to be improved (3.75 mean, SD 0.88). The feedback at their presentation was rated as good (3.84 mean, SD 0.81). The amount of independent work was considered average by the students (2.93 mean, SD 1.00). Students could not relate the assignments presented to them in the course with aspects they thought they would encounter in their future careers (mean 2.53, SD 1.06). The assessments of the RCTs were rated educational at 3.48 (SD 1.03) and students rated their critical appraisal skills as improved (3.86 mean, SD 0.88). The importance of scientific skills for clinicians was clear to the students (3.88 mean, SD 0.80) and the course contributed to this opinion (3.71 mean, SD 0.91).

The results we found regarding the quality of RCTs appearing as references in advertisements in both an independent scientific and a commercial medical journal are secondary and incidental to our findings regarding learning gain and the opinion of students about research-tutored education. However, we would like to report these results because they were surprising and may be of interest. Additionally, they emphasize the need for students to learn how to critically appraise literature.

The initial database of RCT assessments contained 506 assessments of which 49 assessments were considered deviant and these were therefore removed from the database. Thirty-five new assessments were added because a reference was assessed less than three times. The final database consisted of 492 assessments concerning 144 individual references, which appeared in 59 separate advertisements. Sixty-nine appeared in *Huisarts en Wetenschap* only, 44 appeared in *Modern Medicine* only, and 31 appeared in both journals (Figure 1).

The mean reference validity score for references appearing in *Huisarts en Wetenschap* only (n=69) was 13.34 and of those appearing in *Modern Medicine* only (n=44) 14.36 (Table 1). Using our cut-off point of validity score 16, approximately 80% of references appearing in *Huisarts en Wetenschap* only were considered being of suboptimal quality, in contrast to approximately 70% of the references appearing in *Modern Medicine* only. The references appearing in advertisements in *Modern Medicine* scored on average 1.03 (95% CI, 0.41 to 2.02) points higher than those appearing in *Huisarts en Wetenschap*. References related to *Modern Medicine* scored higher regarding blinding of the study (questions five, six, and seven), on average 0.29 (95% CI, -0.01 to 0.59) points higher on blinding of the patient, 0.25 (95% CI, -0.03 to 0.53) points higher on blinding of the care provider, and 0.26 (95% CI, 0.04 to 0.48) points higher on blinding of the outcome assessor.

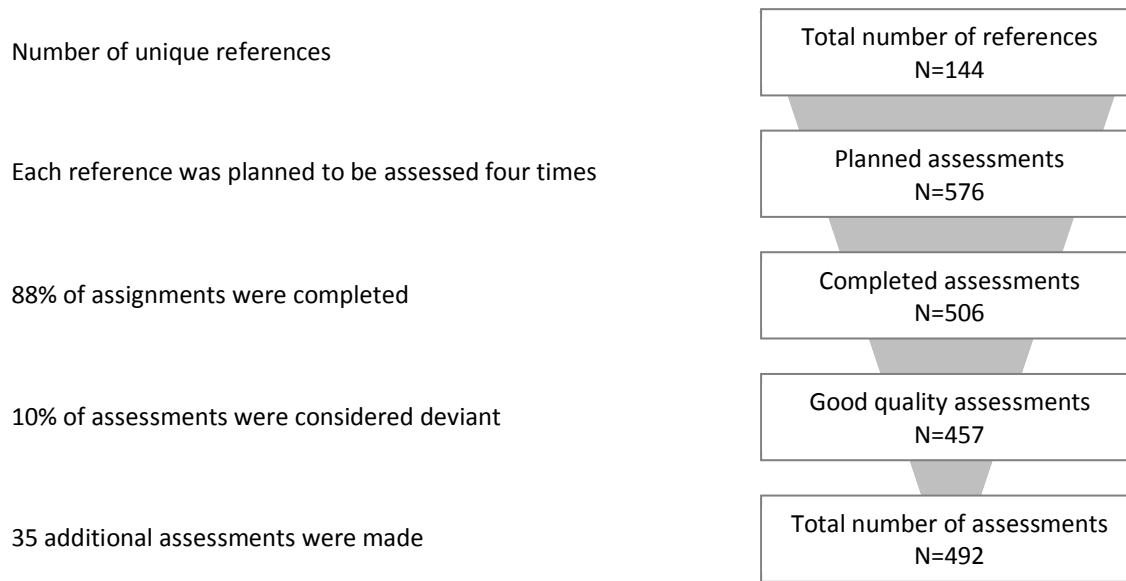


Figure 1: Flow chart of the assessment process.

The 59 advertisements contained information on 44 different drugs. For all drug categories, the mean reference validity score is shown in Table 2. The mean reference validity scores for cardiovascular, pulmonary, and diabetic drug categories were 14.36, 13.90 and 12.14 points, respectively. Hence, the mean reference validity score of diabetic drugs is 2.22 (95% CI, 0.96 to 3.48) points lower than the mean reference validity score of cardiovascular drugs and 1.75 (95% CI, 0.20 to 3.30) points lower than the mean reference validity score of pulmonary drugs.

As noted in Table 2, the references in the diabetic drug category appeared mainly in advertisements in *Huisarts en Wetenschap*. This bias could explain the difference in mean reference validity score. The difference on the reference validity score between both journals, when excluding the diabetic drug category, was smaller, that is 0.63 (95% CI, -0.34 to 1.60) points.

Discussion

The main aim of this study was to assess the opinion of students about research-tutored learning. The results of our study show that this type of learning is an effective way for students to develop an additional set of skills improving their futures as clinicians. This type of research tutored learning not only lets the students benefit from research, students also aid research.

Our results show students are positive about research-tutored education. We tried to achieve optimal reliability of the results from the questionnaire. This was achieved by asking 255 students to fill out the questionnaire and by analyzing the results anonymously. Even though the results only apply to the specific circumstances created during the course Scientific Education, these circumstances can easily be recreated by any medical faculty in the world in order for students to benefit from research-tutored learning.

The use of self-assessment data from the students is a limitation of this study. Because we employed this method we have not directly measured if the critical appraisal skills of students actually improved. Measuring their performance relative to a “golden standard”, for instance the appraisal of a faculty member, before and after our intervention, would have given us a learning outcome to report. With our methods we cannot confirm the learning outcomes of our intervention.

Despite these limitations, we believe that the reported increase of students’ self-efficacy is still relevant. We hypothesize that students with increased self-efficacy will more likely read references associated with advertisements or with new pharmacological therapies in general, because they feel that they have the skills to critically appraise these references. It is far more likely that students learn the required skills while engaging in the activity, as compared to a student with low self-

efficacy, who will not engage in the critical appraisal of references. Additionally, the data from the research performed by the students indicates suboptimal quality of a large portion of references; this might motivate students to critically appraise the literature they encounter during their future careers.

Students were not positive about all aspects of research-tutored learning. They had difficulties relating the appraisal of RCTs and associated education to their future career. Students did, however, understand the importance of scientific training for their future as clinicians. The students' opinion could be explained by the small part each individual student had in the research project. Possibly more effort should be made to show participating students the goal of the project, and to show them more of the data analysis part of the study. Additionally, putting more emphasis on their own development and the relevance of this type of education to their scientific development, of which students do see the importance, could improve the students' ability to relate research-tutored education to their future as clinicians.

In this study, 255 medical students assessed the quality of pharmaceutical advertisements and found that 70-80% of pharmaceutical advertisements in both journals can be considered suboptimal. The students found that the references in advertisements in the commercial journal *Modern Medicine* are not less reliable compared to the references in the advertisements of the independent journal *Huisarts en Wetenschap*. In relation to the quality of advertisements, the publication of advertisements in *Modern Medicine* is, like most journals, determined by the publisher which does not check the references of advertisements [Knuistingh Neven A. 2011, Former chief-editor of *Modern Medicine*, written communication]. Although *Huisarts en Wetenschap* does check if an advertisement is contradictory to the guidelines of the Dutch College of General Practitioners, the references of the advertisements are not checked either [Van Weert HC. 2011, Chief-editor of *Huisarts en Wetenschap*, written communication]. The lack of checking references by both journals may explain the suboptimal quality of a large part of the references and the absence of a difference in reference validity.

Selection of only a single journal from each group is a significant limitation to this study. If one or both journals are not representative to the group, results will be biased. Therefore, we cannot generalize our conclusion and we cannot make a statement about the relationship between the nature of the journal and the quality of the references in general. Using students for the assessments enabled us to examine a large number of references. However, one could argue that students might be unmotivated. In our opinion we prevented this bias with the manual containing exact guidelines on how to score every question, a one-hour informing seminar, two hour training, and an oral presentation of the content of both assigned references to their fellow students and a supervisor. Students validated the clearness of the assessment criteria for the RCTs as 3.93 (SD 0.84), which means assessment criteria were clear. In addition, four students assessed each reference independent from each other and blinded from the origin of their reference. The precise instructions in the manual ensured they would score the references similarly, as is illustrated by the fact that only 49 out of 506 assessments were considered deviant. Panel discussions with two groups of eight and four students confirmed that students took this assignment seriously.

Since the quality of RCTs appearing as references in advertisements has not been well-studied, additional research is needed to improve the knowledge in this field. Furthermore, the possibility of selection of those references with an outcome favorable to the drug advertised would have to be taken into account when regarding the quality of advertisements.

We studied the difference between a commercial and scientific journal concerning the reliability of the references in their advertisements. Although more research is needed to clarify the relationship between the nature of the journal and the quality of the references in its advertisements, this study's conclusion is unexpected but in line with previous research.¹⁹ References in advertisements from a commercial journal are not less reliable, compared to references in advertisements from an independent journal. Several factors might attribute to this: the suboptimal quality of the references in general, the journals lack of focus on advertising policy, or the lack of criticism from readers regarding their advertising policy.

Conclusion

The opinion of students regarding this type of research-tutored learning was positive and they rated the course meaningful for their future as clinicians. They experienced an improvement of their presentation skills and the feedback at the presentation was rated valuable. In addition, they stated to have improved their critical appraisal skills and understand the importance of reading literature during their career. Concluding, this type of research-tutored learning is being rated an effective way for students to develop an additional set of skills improving their future functioning as clinicians. The course design, combining research and education, not only lets the students benefit from research, they also aid it.

Secondary to the results above, we found that in both the commercial and the independent medical journal, 70-80% of included references scored suboptimal. After adjustment for drug category, the quality of references from a commercial journal, are not less reliable, compared to those of an independent journal.

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Keywords

Research-tutored learning, students, randomized controlled trial, learning gain, critical appraisal.

Notes on Contributors

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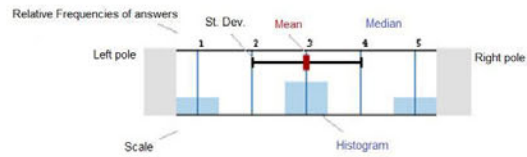
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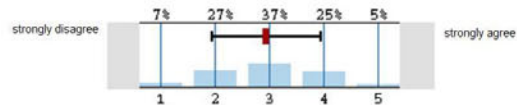
Appendix

Legend

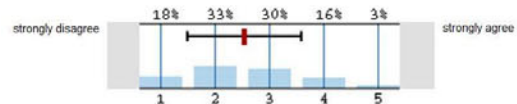
Question Text



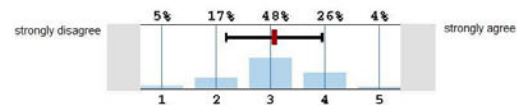
1. I was stimulated to work independent



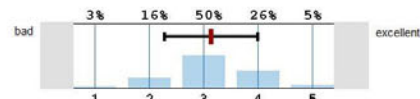
2. The assignments included aspects I can relate to my future career



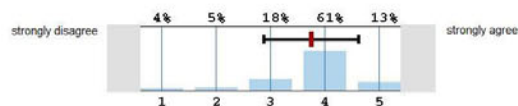
3. I learned a lot during this course



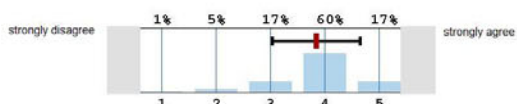
4. My overall assessment about this course is



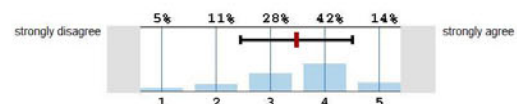
5. By training my skills in presenting are improved



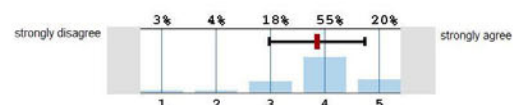
6. The feedback format in the course presentation techniques was educative



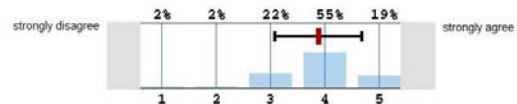
7. The assessment of RCT's was educative



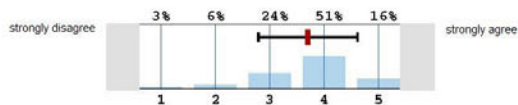
8. I learned to read articles more critically



9. I understand the importance of scientific training for my future career as a doctor



10. This course contributed to my scientific attitude



The questionnaire concerns the course Scientific Education. A scoring system of one to five was used, the answer option one represented total disagreement with the given statement, the answer option three represented a neutral position, and the answer option five represented total agreement. The vertical bars and percentages above them indicate the frequency distribution of the responses. The horizontal black bars indicate the standard deviation of the answers. The red bar indicates the mean.