ORIGINAL CONTRIBUTIONS

ARTICLES

Influence of Tutors' Subject-matter Expertise on Student Effort and Achievement in Problem-based Learning

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Purpose. To investigate the effects of tutors' subject-matter expertise on students' levels of academic achievement and study effort in a problem-based health sciences curriculum. Also, to study differences in tutors' behaviors and the influences of these differences on students' performances. **Method.** Data were analyzed from 336 staff-led tutorial groups involving student participants in seven four-year undergraduate programs at the University of Limburg Faculty of Health Sciences in 1989–90. Overall, 1,925 data records were studied, with each student participating in an average of 1.7 groups led by either content experts or non-experts. The basic analyses were of (1) students' achievement scores as a function of tutors' expertise levels and students' curriculum year; (2) students' estimates of self-study time as a function of tutors' expertise levels and students' curriculum year; and (3) the average ratings of the tutors' behaviors as a function of tutors' expertise levels. Statistical methods included analysis of variance and Pearson correlations. **Results.** The students guided by subject-matter experts were shown to spend more time on self-directed study, and they achieved somewhat better than did the students guided by non-expert tutors. The effect of subject-matter expertise on achievement was strongest in the first curriculum year, suggesting that novice students are more dependent on their tutors' expertise than are more advanced students. Also, the content-expert tutors made more extensive use of their subject-matter knowledge to guide students. However, in addition to the tutors' knowledge-related behaviors, the tutors' process-facilitation skills affected student achievement. Moreover, these two sets of behaviors were correlated, indicating that both are necessary conditions for effective tutoring. **Conclusion.** The results indicate that, at least for the curriculum studied, the assumption in the literature that tutors do not necessarily need content knowledge so long as they are skilled in the tutoring process is not entirely justified: the students who were guided by content experts achieved somewhat better and spent more time on self-directed learning. More important, tutoring skill and content knowledge seemed to be necessary and closely related conditions for effective tutoring. *Acad. Med.* 68(1993):784–791.

Howard Barrows[1,2] suggests that the task of a tutor in a problem-based tutorial group should be to facilitate the learning of students rather than to convey knowledge. In his 1985 book he puts it this way:

> Instead of giving students the information and facts they need through lectures and readings, they [i.e., tutors] must learn to facilitate and indirectly guide student learning. They must allow students to determine on their own what they need to know and to learn through the study of varied resources, especially the teachers in your faculty. Instead of telling the students exactly what they should learn and in what sequence they should learn, the tutor must help students determine this for themselves.[2]

This task should be accomplished by tutors' asking for clarification in a non-directive fashion, such as "What do you think?" or "I don't understand what your point of view is." According to Barrows, these process-facilitation skills are more important than subject-matter expertise. Although he suggests that the best tutor would be somebody who possesses relevant subject-matter knowledge and is a good facilitator, he considers process-facilitation skills to be particularly crucial for the learning of students.[3] He states:

> I have tutored in many areas in which I was not an expert and found it easy and enjoyable. A little preparation always helps, but not much is needed. Certainly, if you are tutoring in an unfamiliar area you should orient yourself before the course starts to the course objectives and the problems that are used. . . . [But] A faculty person who is a good tutor can successfully tutor in any area.[2]

Barrows' point of view has recently become the subject of considerable controversy. Eagle et al.,[4] for instance, demonstrated that students guided by content-expert tutors produced more than twice as many learning issues for self-directed learning and spent almost twice the amount of time on self-study as did students guided by non-expert tutors. Davis et al.[5] found that

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performance on an achievement test was enhanced when students were guided by a content expert. On the other hand, some Harvard studies[6,7] suggest that content expertise has negative effects on tutoring. Silver and Wilkerson,[7] for instance, showed that expert tutors tended to take a more directive role in the tutorials, spoke more often and for longer periods, provided more direct answers to students' questions, and suggested more items for discussion. Tutor-to-student exchanges predominated, with less student-to-student discussion.

The present article aims at contributing to the discussion in two ways: first, it provides a more comprehensive review of studies conducted in this area than previous authors were able to supply, including a number of yet unpublished studies. In addition, results of a large-scale experiment involving 336 tutorial groups, carried out to investigate effects of content expertise on the processes and products of problem-based learning, are reported.

REVIEW: EFFECTS OF TUTORS' CONTENT EXPERTISE ON STUDENT LEARNING

In an early study assessing the impact of content expertise on student learning, Schmidt[8] compared the levels of achievement of second-year medical students in three courses, or units, of the University of Limburg's problem-based curriculum. In the comparison, about 150 students and 20 tutors were involved. Both students and tutors were randomly assigned to the tutorial groups. About half of the tutors were non-medical, such as social science and basic science staff. They were considered non-experts with regard to the topics at hand. Staff with medical degrees were considered the subject-matter experts. End-of-unit tests were used as the dependent variable. The study revealed no difference in levels of achievement related to content expertise of the tutor. In fact, one of the best-performing groups was guided by a laboratory assistant (at the time, the University of Limburg involved academic as well as non-academic tutors in its curriculum). In another study,[9] carried out at the same institution, effects of expertise of approximately 230 tutors on the performances of 600 students were studied, again using end-of-unit tests as the dependent measure. Since the particular curriculum integrated biomedical, clinical, and psychosocial aspects of medicine in each unit, the investigators subdivided each end-of-unit test according to these three categories and studied the impacts of tutors' professional backgrounds on student performances on the resulting subtests. No effect of expertise was found.

Investigators at the Université de Sherbrooke, in Canada,[10] analyzed achievement data of two consecutive cohorts of students, involving approximately 200 students and 170 tutors, half of whom were considered content experts. The measurement of achievement consisted of three parts for each individual student: a multiple-choice test, short essay questions, and a tutor's judgment regarding the student's performance. No differences emerged on the multiple-choice tests. In one of the two years, the students guided by expert tutors performed significantly better on the essay tests. The authors attributed this finding to the fact that the experts were actually involved in the production of the questions for this test, which may have contaminated the results. In addition, the expert tutors judged their students generally as poorer than did the non-expert tutors. A composite score of the three measures, however, did not reveal any significant difference.

A number of investigators, predominantly at the University of Limburg, compared the performance of students guided by staff tutors with that of students guided by student tutors. In these studies, the student tutors were considered relatively non-expert as compared with the academic staff. De Volder and colleagues,[11] compared the achievement levels of health sciences students in three consecutive units. In total, 17 student-guided groups were compared with 28 groups guided by staff tutors. Assignment to groups was random. The investigators found significant differences favoring staff tutors in one unit but failed to discern differences in the other two. A second study by the same authors[12] that compared 11 student-tutored with six staff-tutored groups revealed no difference. Gijselaers and coworkers[13] compared 20 student-tutored with 26 staff-tutored groups in two units within a problem-based economics curriculum and found a difference in achievement levels favoring staff tutors in one of the units. In the second unit, however, no difference was found. A study of law students by Moust and associates,[14] involving ten student tutors and ten staff tutors, revealed a significant difference supporting the hypothesis that tutors' content expertise indeed facilitates student performance. A follow-up in two other units by Moust,[15] however, failed to replicate the findings of the previous study. Gruppen and colleagues,[16] at the University of Michigan, involved 12 tutorial groups in alternating student-led and staff-led sessions. The total number of sessions was four. They found no difference in levels of performance.

The results of the studies reviewed here are generally inconclusive. Of the four studies comparing academic achievement levels of students guided by tutors of different levels of subject-matter expertise, one demonstrated an effect. As is argued below, the latter study, conducted at the University of Michigan,[5] is, however, somewhat atypical. Of the studies comparing staff tutoring with student tutoring, three of ten demonstrated significant differences favoring students guided by staff tutors. There may be several reasons for these ambiguous findings.

The first may be related to the definition of what actually constitutes subject-matter expertise in small-group tutoring. An extremely stringent definition of what constitutes a content-expert tutor, for instance, was applied in the University of Michigan study.[5] Only those who had an active research interest in the specific topic studied by the students were considered content experts. (Davis and colleagues studied the performances of students after they had worked on an influenza case for four consecutive sessions. Their experts were virologists and immunologists who were actively involved in influenza research. The non-expert group consisted of the same categories of basic science staff, but the non-expert tutors lacked research experience in this area. It is questionable whether such a definition if helpful in understanding the role of the tutor in problem-based learning. If the definition is taken seriously, nobody will ever be considered an expert in a problem-based unit, since nobody will entertain as many research interests as there are cases in one unit.)

In the studies comparing staff with student tutoring, on the other hand, content expertise was considered equivalent to the level of training of the tutor and not so much to his or her specific knowledge. This may imply that some staff tutors employed in these studies were not really content experts in a stricter sense of the word. (There is some evidence that this may be a source of non-significant findings. By removing a number of non-expert staff from his analyses, Moust[14] demonstrated—a posteriori—that content expertise indeed made a difference in terms of student achievement.)

The two studies conducted at the University of Limburg Medical School[8,9] employed three broad subject-matter categories to characterize tutor expertise: biomedicine, clinical medicine, and the social sciences. This definition would allow a cardiologist in a pediatrics unit to be considered a content expert. As a result, the analyses may not have been sufficiently sensitive to possible differences. The Sherbrooke study,[10] by contrast, defined expertise uniquely in relation to the unit content, e.g., a gynecologist was considered an expert in a gynecology unit but not in a cardiovascular unit. In addition, this study employed a self-report measure of expertise by which tutors could indicate to what extent they considered themselves experts in the context of a particular unit. Despite this obviously more adequate formulation of what content expertise in tutoring may imply, the Sherbrooke group failed to find any expertise-related effect.

A second reason for the inconclusiveness of the findings may be the magnitudes of the samples studied. Most studies examined effects of subject-matter expertise in one single unit or even part of a unit. Only two studies included an entire year or an entire curriculum.[9,10] Even if the subject-matter expertise of the tutor makes a difference, its influence is bound to be small. Students spend relatively little time with their tutor and during these encounters, the verbal contributions of the tutor are mostly limited. Reliable effects, if any, will show up only when sufficient numbers of tutorial groups are included in the analysis, that is, if the power of the statistical test applied is sufficiently great. Only a few studies fulfilled this criterion, and all of them failed to demonstrate differences.

The extent to which students are exposed to problem-based learning may also be a factor. It is often observed that students who have little or no experience with problem-based learning rely more heavily on their tutors as sources of guidance and information. If these tutors are familiar with the subject matter to be mastered, this may make a difference. This observation may explain why the positive findings reported were largely confined to first-year units. Novice students may lean more on their tutors' expertise than do students in later years. Therefore, one may assume that differences will be more easily produced in an educational context where students are not, or are only in a limited fashion, exposed to problem-based learning. This may in particular apply to the University of Michigan study,[5] undertaken within a conventional medical curriculum.

A final reason for the inconclusiveness of the findings may be that in the studies that did not report differences, the experts did not behave differently from the non-experts. In many of the problem-based programs, though not in all, tutors were actually discouraged to intervene or otherwise direct the learning processes of the students. Under these conditions, expert tutors may have had difficulty putting their marks on the extents of learning of their students. The Sherbrooke study may be an example. Tutors were rated by students on various facilitative behaviors, including the extent to which they used their subject-matter expertise to help students. On only one of seven critical behaviors was a significant difference found, suggesting that expert and non-expert tutors behaved in much the same ways. Three other studies that do, in fact, demonstrate differences in behavior between experts and non-experts do not report data on student achievement.[4,7,17] Alternatively, the Davis et al. study,[5] showing differences in achievement, failed to discern any difference in actual tutor behaviors, although the investigators used a fairly elaborate observational method.

METHOD

In the present study an attempt was made to avoid some of the pitfalls of previous studies, in the pursuit of a better understanding of the role of the tutor in problem-based learning. First, a tutor's content expertise was defined relative to the content of the unit in which he or she tutored, much in the way it was done in the Sherbrooke study.[10] Second, data involving an entire problem-based curriculum and more than 150 tutors were analyzed, thereby avoiding the lack of statistical power that may have plagued some of the smaller-scale studies reviewed. Third, an attempt was made to measure differences in actual behavior between experts and non-experts and their consequences for student learning. To that end, data from 113 units of the University of Limburg's health sciences curriculum were analyzed.

Educational Context

The University of Limburg Faculty of Health Sciences offers seven undergraduate programs, ranging from nursing science to a program preparing students for careers in biomedical research. After a common first curriculum year, the health sciences students enter their programs of choice. The various specialization programs have the same duration, three years.

So, in order to graduate, students spend at least four years within the school. All programs use problem-based learning as the vehicle for student learning. The curricula consist of six-week units, each dedicated to a multidisciplinary theme. Students work in groups of ten, each guided by a tutor. These groups meet twice a week for two hours to discuss the problems presented and to exchange information gathered through self-directed learning. At the end of each six-week unit, students fill in a questionnaire inquiring about various aspects of the program, including the functioning of their tutor. In addition, an achievement test is administered.

Participants

The participants were 1,120 students in four curriculum years during the academic year 1989–90. Each student participated in, on average, 1.7 tutorial groups guided by a staff tutor. Since some of the tutorials were run by student tutors, the whole population of students was not included in the analysis. The 152 tutors participating in the experiment ran 336 tutorials in 113 units. Each tutor ran, on average, 2.2 tutorials. The average number of students completing the questionnaire and achievement test per tutorial group was 5.7. Tutorial groups with fewer than four respondents were removed from the sample. The total number of data records—the number of students included in the study times the number of tutorials in which they participated—was 1,925.

Instruments

Achievement was measured by 100–150 true–false items (in the first year) and by short essay questions (in subsequent years). The results were transformed to a scale ranging from 0 to 10, 6 being the passing score.

The students were asked to estimate how many hours of self-directed study, on average, they had spent each week. Time spent on self-study is generally considered an adequate measure of effort. A study by Eagle and colleagues[4] showed that students guided by content experts spent almost twice as many hours on self-study.

Tutor functioning was measured by means of an 11-item Likert-type rating scale. Each item consisted of a statement with which students could agree or disagree to different degrees (ranging from 1, strongly disagree, to 5, strongly agree). These items dealt with various aspects of tutor behavior in the tutorial groups. A study by Gijselaers[18] demonstrated for these items an average interrater reliability—expressed as an average intraclass coefficient—of .71. For the purpose of the present study, two subscales were constructed out of these 11 items: a four-item process-facilitation scale and a four-item subject-matter-input scale. The process-facilitation scale was intended to measure the skills considered crucial to successful tutoring as outlined by Barrows. It included items such as asking stimulating questions and monitoring the group's progress. The subject-matter-input scale contained items referring to the ways in which the tutor made use of his or her subject-matter knowledge to help students. A recent study has demonstrated that these two subscales have considerable validity as indicated by the results of a confirmatory factor analysis.[19]

Procedure

For each unit, the students and tutors were randomly assigned to the groups. Two independent judges rated each of the tutors in each of the units as either a non-expert, a semi-expert, or an expert with respect to the subject matter of the unit. Non-experts were tutors whose previous training was unrelated to the topic at hand, e.g., an educationalist in a unit on blood. Semi-experts were tutors who had general background knowledge regarding the unit but no specific expertise, e.g., an epidemiologist tutoring a unit on health care management. Experts were tutors with fairly specific background knowledge, e.g., a biochemist in a unit on nutrition. Consequently, the same tutor may have been labelled a content expert in one unit and a non-expert in another unit. Interrater agreement was over 80%. Differences of opinion emerged mainly in the semi-expert category. Therefore, it was decided to add these tutors to the non-expert category. The data were analyzed using analysis of variance.

RESULTS

Academic achievement. Table 1 shows the students' average achieve-

Table 1

Average Achievement Scores of Health Sciences Students as a Function of Staff Tutors' Expertise Level and Students' Curriculum Year, University of Limburg, 1989–90*

Type of Staff Tutor	Average Score per Curriculum Year				Average Score over 4 Years
	Year 1	Year 2	Year 3	Year 4	
Non-expert	6.50 (352 scores)	6.75 (197 scores)	6.82 (153 scores)	6.82 (28 scores)	6.65 (730 scores)
Expert	6.78 (258 scores)	6.84 (421 scores)	6.90 (388 scores)	6.69 (128 scores)	6.83 (1,195 scores)

*The University of Limburg Faculty of Health Sciences offers seven four-year undergraduate programs, all using problem-based learning. At the end of each six-week unit, students are administered achievement tests, with scores ranging from 0 to 10, with 6 being the pass score. The present study involved 1,925 student scores (on average, a student participated in 1.7 staff-led tutorial groups).

Table 2

Average Estimates of Self-study Time by Health Sciences Students as a Function of Staff Tutors' Expertise Level and Students' Curriculum Year, University of Limburg, 1989–90*

Type of Staff Tutor	Average Estimate per Curriculum Year (in Hours per Week)				Average Estimate over 4 Years
	Year 1	Year 2	Year 3	Year 4	
Non-expert	15.65 (339 estimates)	20.30 (198 estimates)	17.67 (150 estimates)	12.37 (35 estimates)	17.19 (722 estimates)
Expert	16.56 (258 estimates)	21.52 (412 estimates)	20.63 (384 estimates)	18.26 (139 estimates)	19.78 (1,193 estimates)

*The University of Limburg Faculty of Health Sciences offers seven four-year undergraduate programs, all using problem-based learning. The table shows students' estimates of the average numbers of hours they spent per week on self-study when they participated in tutorial groups led by staff who were either content experts or non-experts. The present study involved 1,915 estimates (on average, a student participated in 1.7 staff-led tutorial groups).

ment scores with tutor's expertise level and students' curriculum year as the independent variables. The effect of expertise level is statistically significant ($F_{1924,\ 1} = 6.77$, $p < .01$, $MS_e = 1.17$). So is the effect of curriculum year ($F_{1924,\ 3} = 4.32$, $p < .01$, $MS_e = 1.17$). No interaction effect occurred between expertise level of the tutor and students' curriculum year. Interestingly, the effect of expertise is mainly located in the first year ($F_{609,\ 1} = 11.04$, $p < .01$, $MS_e = 1.07$). Inspection of the data reveals that this difference exists not so much because the students guided by content experts performed better, but because the first-year students guided by non-experts performed more poorly than did their non-expert–led colleagues in subsequent years. In each of the three subsequent years, no significant difference emerged.

Self-study time. Table 2 shows average self-study data under the conditions of the experiment. The effect of tutor expertise on students' self-study time is highly significant ($F_{1914,\ 1} = 16.72$, $p < .001$, $MS_e = 87.66$); so is the effect of curriculum year ($F_{1914,\ 3} = 27.77$, $p < .001$). Contrary to the findings with respect to academic achievement, the effect of expertise on self-study time concentrates in the third and fourth years: $F_{533,\ 1} = 10.59$, $p < .001$, and $F_{173,\ 1} = 12.05$, $p < .001$. Differences in the first two years are nonsignificant.

Tutor behavior. Table 3 shows differences in ratings between expert and non-expert tutors on a number of tutorial behaviors. Response patterns were generally similar over the curriculum years; therefore, only totals are presented.

Average scores were computed for each tutor on both the process-facilitation and the subject-matter–input subscales. The resulting data were first rounded, so that each tutor could be assigned to one of five score levels for each subscale. Subsequently, students' average achievement scores were computed for each of the five levels of these scales in order to provide an insight into the extent to which these tutor behaviors were causally related to achievement. Tables 4 and 5 contain the relevant data. Table 4 should be read as follows: 18 tutors received an average score of 1 (rounded) on the process-facilitation subscale. The students of the groups guided by these tutors had an average achievement score of 6.28. There were 118 tutors who had an average score of 2 on the same subscale. Their students received an average achievement score of 6.64, and so forth. Table 5 must be interpreted in the same manner.

The effect of level of process facilitation on student achievement is statistically significant ($F_{1913,\ 4} = 4.47$, $p < .001$, $MS_e = 1.17$). So is the effect of level of subject-matter input on achievement ($F_{1909,\ 4} = 4.07$, $p < .01$, $MS_e = 1.18$).

DISCUSSION

It seems that Barrows' assumption[1–3] that tutors do not necessarily need domain knowledge in order to facilitate student learning is not entirely justified, at least not with regard to the curriculum studied. Tutorial groups guided by a content-expert tutor achieved better and spent more time on self-directed learning. The overall difference in levels of achievement was, however, fairly small: .18 on a scale actually ranging between 4 and 9 in the population studied. The effect size equals .165, which, according to Cohen,[20] can be considered minor.

The difference was largest in the first curriculum year. This finding seems to support the informal observation alluded to in the introduction, that students who have been exposed to problem-based learning only to a limited extent tend to lean more heavily on their tutors. If the subject-matter expertise of a tutor is to play a role in the learning of students, its influence will be most pervasive in those cases where students rely most extensively on their tutors for guidance. This may be particularly the case in the first year, when students still have to adapt to the requirements set by the problem-based approach. When, through experience, students become more self-directed and independent of their tutor, his or her influence on student learning may become smaller. Further support for this notion is provided by the observation that the first-year students guided by non-experts actually performed more poorly than did their expert–led colleagues in subsequent curriculum years. This finding also supports the notion that

Table 3

Average Ratings of Staff Tutors' Behaviors by Health Sciences Students as a Function of Tutors' Expertise Level, University of Limburg, 1989–90*

Item Describing Tutor Behavior	Average Rating: For Expert Tutors	Average Rating: For Non-expert Tutors	*F* observed†
The tutor displayed a fair understanding of this unit's objectives (SMI).	4.16	3.92	35.81‡
The tutor displayed knowledge of the principles underlying problem-based learning.	4.15	3.99	17.05‡
One had the impression that the tutor liked his or her role.	3.92	3.85	—
The tutor encouraged us to work hard (PF).	3.55	3.42	9.80§
The tutor's questions stimulated the discussion (PF).	3.87	3.79	—
At regular intervals, the tutor evaluated with us the group's functioning (PF).	3.17	3.55	61.92‡
The tutor appeared to be sufficiently knowledgeable with respect to this unit's topics (SMI).	4.25	3.76	132.08‡
The tutor frequently used his or her subject-matter knowledge to help us (SMI).	3.91	3.48	86.60‡
The tutor intervened in ways that disturbed the progress of the group discussion (PF).	1.89	1.85	—
The subject-matter contributions of the tutor were relevant (SMI).	4.11	3.84	46.33‡
Taken together, the tutor played his or her role well.	4.07	4.07	—

*The University of Limburg Faculty of Health Sciences offers seven four-year undergraduate programs, all using problem-based learning. The table shows the average ratings given staff tutors by students across all four curriculum years. In all, 1,925 ratings were used in the study (on average, a student participated in 1.7 staff-led tutorial groups). The ratings were scaled from 1, strongly disagree, to 5, strongly agree. Four of the items rated were used to construct a subject-matter-input (SMI) subscale, intended to measure the ways in which the tutors made use of their content expertise to help the students. Four other items were used to construct a process-facilitation (PF) subscale, intended to measure the skills previous authors have considered crucial to successful tutoring.

†Degrees of freedom associated with these observed *F*-values averaged 2,070; MS_es averaged .78.

‡Statistically significant at the .001 level.

§Statistically significant at the .01 level.

Table 4

Average Achievement Scores of Health Sciences Students According to Their Staff Tutors' Levels of Skill in Process Facilitation, University of Limburg, 1989–90*

	Tutors' Process-facilitation Level				
	1	2	3	4	5
Students' average achievement score	6.28 (18 tutors)	6.64 (118 tutors)	6.67 (682 tutors)	6.80 (918 tutors)	6.98 (178 tutors)

*The tutors' process-facilitation levels were determined by calculating the average rating the students gave each tutor on the four items in the process-facilitation subscale (see Table 3); the average ratings ranged from 1, low level, to 5, high level. See text for fuller explanation.

Table 5

Average Achievement Scores of Health Sciences Students according to Their Staff Tutors' Levels of Subject-matter Input, University of Limburg, 1989–90*

	Tutors' Subject-matter-input Level				
	1	2	3	4	5
Students' average achievement score	6.66 (29 tutors)	6.55 (95 tutors)	6.62 (387 tutors)	6.78 (931 tutors)	6.88 (468 tutors)

*The tutors' subject-matter-input levels were determined by calculating the average rating the students gave each tutor on the four items in the subject-matter subscale (see Table 3); the average ratings ranged from 1, low level, to 5, high level. See text for fuller explanation.

novice students are more dependent on their tutor's subject-matter expertise than are more advanced students and, accordingly, are affected to a larger extent if their tutor lacks the necessary knowledge.

However, this notion is not supported by the data on self-study time. Here, the influence of the content-expert tutor is most apparent in the final years. Overall, the students guided by content experts reported spending 15% more time on self-study, whereas in the fourth year the difference was no less than 47%. There is no simple explanation for this result. The finding is particularly counterintuitive if one believes that there must be some kind of causal relationship between effort and achievement, a finding often reported in the literature. However, the product-moment correlation coefficient between time spent and achievement is low ($r = .11, p < .001$). This seems to indicate that increased effort under the influence of tutor expertise only marginally translates itself into better achievement.

The effects of the tutors' subject-matter expertise on effort and academic achievement as reported in this article were somewhat unexpected. The first reason is that the tutor training that faculty receive upon being employed by the University of Limburg focuses on the more general aspects of small-group tutoring, such as how to ask open-ended questions and how to evaluate a group's functioning. In addition, procedures to be used by a group in order to transform a problem into a set of learning issues are emphasized.[21] Only little attention is given to issues dealing with how to use one's own subject-matter knowledge to facilitate student learning. It is, therefore, surprising to note that the subject-matter knowledge of the tutor nevertheless played a non-negligible role in the learning of students. Second, tutors generally play a limited role in the variant of problem-based learning practiced in the curriculum studied. They are advised to leave the initiative to students and provide guidance only if the latter fail to come up with useful ideas regarding the problem at hand or plan to pursue learning issues irrelevant to that problem. Active involvement is discouraged, if not by the guidelines provided by the school, then by students themselves, who come to appreciate being in charge of their own learning and perceive the tutor as a safeguard rather than as a guide. Unlike students in some other problem-based schools, students at the University of Limburg chair their own sessions, leaving only little room for a tutor, expert or non-expert, to exert much influence on the course of learning.

The question, then, is how content-expert tutors, despite these limiting factors, nevertheless are able to influence their students' efforts and achievement. The answer is that they behave differently while tutoring a group. In the present study, the students' ratings of their tutors' performances showed that the subject-matter experts displayed a deeper understanding of the objectives of the particular unit, appeared to be more knowledgeable about the subjects to be mastered by the students, and used their subject-matter knowledge more frequently in order to help the students (and their contributions in this respect were more relevant). The non-expert tutors, on the other hand, evaluated the group's functioning more often.

The data discussed thus far seem to indicate that subject-matter expertise is really what counts in small-group tutoring: content experts display more content-related behaviors while tutoring, resulting in better achievement and greater effort by their students. If this is the conclusion the reader draws from the evidence presented, it certainly is an incomplete deduction. Concluding that subject-matter expertise is a relatively important, and thus far largely neglected, factor in small-group tutoring by no means implies that the opinions held by Barrows and others regarding the role of process-related behaviors are irrelevant. One of the more intriguing results of the present study is that process-facilitation behaviors such as asking questions and evaluating the group's progress are causally related to achievement in much the same way as subject-matter-related behaviors. In other words, an effective tutor appears to be someone who uses his or her subject-matter knowledge and at the same time is able to ask stimulating questions. In addition, subject-matter input and process facilitation turn out to be correlated. The product-moment correlation coefficient is .69. This finding suggests that using one's subject-matter knowledge adequately is directly related to being able to facilitate the learning process of students. In hindsight, this finding is not earthshakingly surprising. Facilitating the learning process of students cannot simply be a matter of knowing how to ask questions; a tutor also needs to know *what* to ask.

In conclusion, both subject-matter knowledge and process-facilitation skills seem to be necessary conditions for effective tutoring. The present study suggests that they are intimately intertwined in the behaviors of effective tutors and that both contribute to the learning of students. This implies that parties who stress the importance of one at the expense of the other in the ongoing controversy on the role of the tutor in problem-based learning may be wrong. It also implies that the training and selection of tutors should take into account these two sides of largely the same coin.

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