

CHAPTER 10

Peer Teaching and Problem-Based Learning: Tutor Characteristics, Tutor Functioning, Group Functioning, and Student Achievement

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Health sciences education at the University of Limburg (Maastricht, the Netherlands) features problem-based small-group discussions alternated with self-directed learning. This problem-based, self-directed learning method is designed to teach problem-solving skills, self-learning skills and enhance motivation and knowledge retention (Schmidt & De Volder, 1984). The

small discussion group consists of about nine students. In these groups, health sciences phenomena (so-called problems) are analyzed and learning goals are formulated (Schmidt, 1983). The groups are guided by tutors who are faculty members. The role of the tutor mainly consists of stimulating the discussion, not giving lectures. In 1981 the role of tutor began to be assigned not only to faculty staff but also to (undergraduate) students. Research regarding effectiveness of this innovation (De Volder, De Grave, & Gijsselaers, 1985) showed the need for more research on process variables, especially the actual tutoring behavior of student tutors and staff tutors. According to Collier (1980) there exists a wide variety of approaches among tutors, ranging from the individual who stifles student exploration of ideas by authoritative interventions in discussion; or the one who feeds the dependency relationship by supplying answers to every request for views; to the constructively aggressive tutor who counters the collusion of some groups to deny conflict and to arrive at a quick consensus; or the one who acts as a catalyst, clarifying and amplifying without prescribing. According to Barrows and Tamblyn (1980) the skills of the tutor in problem-based learning do not relate so much to the abilities to dispense knowledge and understanding as an expert in the areas of science or medicine, as they do to the abilities to help develop skills in scientific reasoning, self-study and self-evaluation.

In our study, we focus on the effects of different leadership conditions on process and product variables by comparing student tutors with staff tutors with respect to tutor behavior, group functioning, and test achievement of students. In order to explain these effects, two theoretical approaches are of interest: These are *role theory* and *cognitive congruence theory*.

Role theory (Allen, 1976) suggests that teachers and students have different stereotypical roles with different expectations, responsibilities, and status. Role similarity of student tutors and students would have beneficial effects on the motivational level. In the problem-based learning context, it can therefore be expected that the student tutor will show a very strong commitment to his or her role, being very active and enthusiastic. Cognitive congruence theory (Cornwall, 1979) states that experts differ from novices in their cognitive structures. This means that there exists cognitive incongruence between students and staff tutors, but cognitive congruence between students and student tutors. Because of this cognitive congruence, it is supposed that the student tutor is better able to assess the prior knowledge of the students when explaining something; is better able to use the

same language, concepts, and examples as the other students; and is better able to know what problems students are experiencing when dealing with the subject matter. In addition to this theoretical relevance, our study also has practical implications regarding which criteria should be used for the selection of student tutors, and how students should be trained in order to prepare them for the role of tutor.

METHOD

The first year of the program in health sciences at the University of Limburg is divided into block periods of 6 weeks each. The fourth period is devoted to an introduction to health education. Study groups of about nine students meet twice a week for a 2-hour session to discuss theme-relevant topics monitored by a faculty member, the so-called tutor. In the academic year 1983/1984 an experiment was carried out in which students of the third curriculum year (who are still undergraduates) were allowed to function as tutors in first-year group meetings. In 1983/1984 there were 165 first-year students, and they were divided into 17 groups. The composition of the groups is changed at random after each block period. Third-year students who volunteered to act as tutors were, without making use of any selection procedure, accepted in order of application, until the necessary quorum was reached. Of the total of 11 student tutors, 6 (the so-called expert student tutors) were specializing in health education. The other 5 student tutors had other specializations within the health sciences (the so-called nonexpert student tutors). All student tutors had taken the first-year block "An Introduction to Health Education." They also had in common 3 years of experience in problem-based learning. Furthermore, they received the same 2-day tutor training that was also a prerequisite for staff tutors. Tutors are free to indicate preferences for certain blocks, which are honored when possible. Within a block, however, tutors (both staff and student tutors) are allocated at random, with only one group per tutor.

At the end of the fourth period (the introduction to health education), first-year students had to fill out a questionnaire that consisted of 26 items (Table 10.1), and the response rate was 99%. Subjects (Ss) indicated their agreement with each item of the questionnaire on a scale from 1 (completely disagree) to 5 (completely agree).

For formative evaluation purposes, the students had to take an

TABLE 10.1 Questionnaire Items on Group and Tutor Functioning

1. I experienced the discussion group meetings as pleasant.
 2. Each member of the discussion group participated in the discussion.
 3. The tutor was well able to assess our prior knowledge with respect to the subject matter at hand.
 4. The tutor aroused interest in the subject matter of this block period.
 5. The tutor appeared to have a clear notion of the goals of this specific block period.
 6. The tutor seemed well informed about the educational principles of this particular instructional approach (problem-based, self directed learning).
 7. The tutor acted as if he or she were a group member (joined in the discussion).
 8. The tutor showed commitment with respect to the group's functioning.
 9. The tutor regularly evaluated with us how our group was proceeding.
 10. The tutor activated us to go deeper into matters.
 11. The tutors stimulated consultation of professional experts.
 12. The tutor regularly posed questions stimulating the discussion.
 13. The tutor regularly performed the role of discussion leader.
 14. The tutor noticed well the group's lack of understanding at certain moments.
 15. Based on the tutor's own professional expertise, the tutor made corrections whenever we proceeded in the wrong direction.
 16. Now and then the tutor clearly summarized the discussion.
 17. On own initiative the tutor elaborately explained certain matters.
 18. The tutor was well able to apprehend the problems we encountered.
 19. On request the tutor explained several difficult parts of the subject matter.
 20. The tutor made suggestions with respect to what might be considered very important and less important in this block.
 21. In my opinion the tutor had expertise with respect to this particular block.
 22. The tutor made suggestions for literature review.
 23. The tutor closely watched the interaction process in the group.
 24. The tutor saw to it that the discussion in the group digged deep.
 25. The meetings were productive.
 26. In general, the tutor performed his or her role well.
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achievement test consisting of true/false items assessing mainly factual knowledge. The test contained 76 items. Reliability (Cronbach's Alpha) was .82.

RESULTS AND DISCUSSION

A *t*-test for independent samples was used to test for differences in achievement of students tutored by staff tutors versus student tutors. No significant difference in test achievement was found (Table 10.2). De Volder, De Grave, and Gijsselaers (1985), in two out of three courses (block periods), also observed no significant differences in achievement between student-tutor and staff-tutor conditions. At this point, it seems safe to conclude that in problem-based learning the role of tutor can be performed by staff as well as by trained undergraduate students as far as test achievement of first-year students is concerned. The presumed superiority of student tutors derived from cognitive congruence theory—at least with respect to tests of factual knowledge—received no support. However, according to Cornwall (1979), the outcome of learning must be specified in terms other than the ability to recall and manipulate the learning material. The variable of depth of learning (Marton & Saljo, 1976) would provide a more significant measure of learning than that usually provided by the conventional achievement test. In their approach, the emphasis is not on the amount of content learned but on how that content is understood by the learner.

Clement (1971) noted that student-led and teacher-led groups equally benefited from discussion, but that students in the student-led groups showed better retention of these effects. More varied and complex measures of learning outcomes should therefore be used in future research on the cognitive congruence hypothesis.

We shall now turn away from product variables toward process variables. *T*-tests for independent samples were used to test for

TABLE 10.2 Test Achievement of Students Tutored by Student Tutors Versus Staff Tutors

<i>Condition</i>	<i>N of students</i>	<i>Mean</i>	<i>SD</i>	<i>Significance test</i>
Staff tutor	56	29.3	8.3	<i>df</i> = 161; <i>t</i> = 0.39, <i>N.S.</i>
Student tutor	107	29.8	8.7	

the differences in group functioning as perceived by students from student-led versus teacher-led groups. Productivity of group meetings and participation of students in the group discussion was not significantly different in student-tutored versus staff-tutored groups (Table 10.3). Students from teacher-led groups experienced group meetings as more pleasant than students from student-led groups (item 1), contradicting role theory assumptions. It is possible that students get unpleasant feelings of insecurity when the "omnipotent" teacher is not present.

On the 23 items referring to tutor behavior, a discriminant analyses was performed to discriminate between students from student-led and teacher-led groups (Table 10.4).

The discriminant function was significant ($\chi^2 = 50.26$, $df = 23$, $p \leq .0009$). Percentage of cases correctly classified was 78%. The most discriminating items will be briefly discussed. Staff tutors, when compared with student tutors, seemed more often to have clear notions of the goals of the block period; to explain certain matters on their own initiative; to watch closely the interaction process in the group; to activate students to go deeper into matters; and to perform the role of discussion leader. These items suggest that the staff tutor behaves more like the subject-matter-expert-on-top-of-things than does the student tutor. The student tutor, when compared with the teacher counterpart, seemed more

TABLE 10.3 Group Functioning as Perceived by Students from Teacher-led Versus Student-led groups

I experienced the discussion group meetings as pleasant (item 1)				
<i>Condition</i>	<i>N of students</i>	<i>Mean</i>	<i>SD</i>	<i>Significance test</i>
Staff tutor	54	3.81	0.80	$df = 157$, $t = 3.05$, $S \leq 0.003$
Student tutor	105	3.38	0.93	
Each member of the discussion group participated actively in the discussion (item 2)				
<i>Condition</i>	<i>N of students</i>	<i>Mean</i>	<i>SD</i>	<i>Significance test</i>
Staff tutor	54	2.96	1.08	$df = 157$, $t = 0.51$, <i>N.S.</i>
Student tutor	105	2.87	0.38	
The group meetings were productive (item 25)				
<i>Condition</i>	<i>N of students</i>	<i>Mean</i>	<i>SD</i>	<i>Significance test</i>
Staff tutor	54	3.35	0.87	$df = 155$, $t = 1.81$, <i>N.S.</i>
Student tutor	103	3.10	0.77	

TABLE 10.4 Staff Tutor Versus Student Tutor: Discriminating Analysis of Items with Respect to Tutor Functioning

<i>Item number</i>	<i>Item content (abbreviated)</i>	<i>Discriminant Coefficient</i>
3.	Able to assess prior knowledge	-0.117
4.	Roused interest in subject matter	0.374
5.	Clear notion of goals of this block	-0.596
6.	Well informed about educational principles	0.216
7.	Acted as if he or she were a group member	0.247
8.	Showed commitment toward group functioning	0.257
9.	Regularly evaluated proceedings of group	0.375
10.	Activated us to go deeper into matters	-0.303
11.	Stimulated consultation of professional experts	0.133
12.	Posed questions stimulating the discussion	-0.087
13.	Performed role of discussion leader	-0.210
14.	Noticed lack of understanding at certain moments	-0.195
15.	Made correction when group was proceeding in wrong direction	0.156
16.	Clearly summarized the discussion	-0.154
17.	On own initiative explained certain matters	-0.557
18.	Was able to apprehend our problems	0.136
19.	On request explained subject matter	0.118
20.	Made suggestions about what was important	0.001
21.	Had expertise with respect to this block	0.165
22.	Made suggestions for literature review	0.157
23.	Closely watched the interaction process in the group	-0.441
24.	Saw to it that the discussion digged deep	0.002
25.	Performed well in his or her role	0.563

often to arouse interest in the subject matter, to evaluate regularly group proceedings; to act as if he or she were a group member; to show commitment toward group functioning; and to generally perform well in his or her role. These items suggest that the student tutor acts more like a colleague than as a superior and is very much concerned about the motivational-emotional climate of the group, as was predicted by role theory (Allen, 1976). The last item (generally perform well in his or her role) strongly suggests that students see the role of tutor not so much as being an expert on subject matter as it is being someone who shows commitment to group processes. Our findings indicate that subject matter expertise is a crucial factor in the functioning of discussion groups and their tutors. Therefore, we decided to perform a secondary analysis on our results with respect to student tutors, dividing them into two groups: expert student tutors

and nonexpert student tutors. Student tutors who are specializing in the same field (health education) as the one that the block period under study dealt with are considered expert student tutors. Student tutors who do not specialize in that field are considered nonexperts.

A *t*-test for independent samples was used to test for the difference in achievement of students tutored by nonexpert versus expert student tutors. No significant difference in test achievement was found (Table 10.5). As far as test achievement is concerned, subject-matter expertise of student-tutors is not essential. It would be interesting to find out whether there exists cognitive congruence or incongruence between expert and nonexpert student teachers. Here, also, more varied and more complex measures of learning outcomes are called for.

A promising approach to the analysis of the relationship between expertise on subject matter and teaching behavior was outlined by Leinhardt and Smith (1985). Interviews, card-sorting tasks, and videotaped lessons were used to develop semantic nets that reflect the subject knowledge of teachers. This way, a more complex and in-depth analysis of subject-matter expertise could be carried out in future research on this topic. *T*-tests for independent samples were used to test for the differences in group functioning as perceived by students from groups tutored by expert students and by nonexpert students (Table 10.6). Participation of students in the group discussion (item 2) was not significantly different in groups tutored by nonexpert versus expert students. Students with expert student tutors found the group meetings to be more pleasant and more productive than students with nonexpert student tutors (item 1 and 25). This indicates that in problem-based learning, group meetings are primarily seen as oriented toward the achievement of learning goals and not so much as social events. It seems that the student tutor

TABLE 10.5 Test Achievement of Students Tutored by Expert Student Tutors Versus Nonexpert Student Tutors

<i>Condition</i>	<i>N of students</i>	<i>Mean</i>	<i>SD</i>	<i>Significance test</i>
Expert student tutors	56	29.0	8.4	<i>df</i> = 105, <i>t</i> = 1.06 N.S.
Non expert student tutors	51	30.8	9.1	

TABLE 10.6 Group Functioning as Perceived by Students from Groups Led by Expert Student Tutors Versus Nonexpert Student Tutors

<i>I experienced the discussion group meetings as pleasant (item 1)</i>				
<i>Condition</i>	<i>N of students</i>	<i>Mean</i>	<i>SD</i>	<i>Significance test</i>
Expert student tutor	55	3.71	0.79	$df = 103, t = 4.01,$ $S \leq 0.000$
Non expert student tutor	50	3.02	0.96	
<i>Each member of the discussion group participated actively in the discussion (item 2)</i>				
<i>Condition</i>	<i>N of students</i>	<i>Mean</i>	<i>SD</i>	<i>Significance test</i>
Expert student tutor	55	3.00	0.96	$df = 103 t = 1.51,$ N.S.
Non expert student tutor	50	2.74	0.80	
<i>The group meetings were productive (item 25)</i>				
<i>Condition</i>	<i>N of students</i>	<i>Mean</i>	<i>SD</i>	<i>Significance test</i>
Expert student tutor	55	3.33	0.70	$df = 103, t = 3.40,$ $S \leq 0.001$
Non expert student tutor	50	2.84	0.77	

who is an expert on subject matter is better equipped to stimulate productivity of groups. This observation has, of course, very important practical implications for the selection and allocation of student tutors. A discriminant analysis was performed on the 23 items referring to tutor behavior in order to discriminate between students with expert student tutors from students with nonexpert student tutors (Table 10.7). The discriminant function was significant ($\chi^2 = 119.80, df = 23, p = 0.0000$). Percent of cases correctly classified was a staggering 94%. The most discriminating items are discussed briefly. Expert student tutors, when compared with nonexpert student tutors, were more often perceived as having subject-matter expertise with respect to the

TABLE 10.7 Expert Student Tutor Versus Nonexpert Student Tutor: Discriminant Analysis of Items with Respect to Tutor Functioning

<i>Item number</i>	<i>Item content (abbreviated)</i>	<i>Discriminant Coefficient</i>
3.	Able to assess prior knowledge	0.371
4.	Roused interest in subject matter	-0.101
5.	Clear notion of goals of this block	0.255
6.	Well informed about educational principles	-0.314
7.	Acted as if he or she were a group member	0.192
8.	Showed commitment toward group functioning	-0.056
9.	Regularly evaluated proceedings of group	0.156
10.	Activated us to go deeper into matters	-0.275
11.	Stimulated consultation of professional experts	0.427
12.	Posed questions stimulating the discussion	0.114
13.	Performed role of discussion leader	0.348
14.	Noticed lack of understanding at certain moments	0.142
15.	Made correction when group was proceeding in wrong direction	0.334
16.	Clearly summarized the discussion	-0.280
17.	On own initiative explained certain matters	0.073
18.	Was able to apprehend our problems	0.212
19.	On request explained subject matter	0.018
20.	Made suggestions about what was important	0.001
21.	Had expertise with respect to this block	0.744
22.	Made suggestions for literature review	0.174
23.	Closely watched the interaction process in the group	-0.179
24.	Saw to it that the discussion digged deep	-0.169
25.	Performed well in his or her role	-0.351

block period in question; stimulating consultation of professional experts; making corrections when the group proceeds in the wrong direction, being able to assess prior knowledge; performing the role of discussion leader; having a clear notion of the goals of the block period; and being able to apprehend students' problems.

The expertise on subject matter of the expert student tutors is clearly recognized by their students in their actual tutoring behavior, which is very content oriented and directive. Nonexpert student tutors, when compared with their expert counterparts, seem more often to be well informed about educational principles, to activate students to go deeper into matters, to clearly summarize the discussion, and to perform well in his or her role. The

absence of subject-matter expertise is conspicuous. Therefore, it seems that nonexpert student tutors are resigned to nondirective and process-oriented tutor behaviors. As we have already seen, students seem to have this type of role in mind when they answer item 26. In our view, however, they are mistaken. Although no effect of different leadership conditions on test achievement could be shown, our study clearly indicates that tutor and group functioning in the staff-tutor and expert-student tutor conditions are to be preferred. Being both subject-matter experts and peers, expert student tutors even seem to hold a small advantage compared with staff tutors.

Perhaps this can be explained by the findings of De Volder (1982) who found that only about half of staff tutors considered themselves experts with respect to subject matter dealt with in the block period to which they were assigned as tutors. Our study confirms the suggestion of De Volder (1982) that there are good reasons to allocate tutors (be it staff or students) to block periods for which they are subject-matter experts. We are not, by any means, implying tutors should give lectures during group meetings. The main conclusion of our study is that a tutor who is also an expert on subject matter is more able to put into practice the full diversity of the tutor role in problem-based learning.

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