Higher Education 18: 737–742(1989)

Peer teaching and higher level cognitive learning outcomes in problem-based learning

J.H.C. MOUST, M.L. DE VOLDER & H.J.P. NUY
University of Limburg, Educational Research and Development, Maastricht, The Netherlands

Abstract. Law education at the University of Limburg (Maastricht, The Netherlands) features small-group tutorials alternating with periods of independent study. Every group of 10 students was tutored by a staff member or an undergraduate student from the third or fourth year. Students guided by a staff member scored significantly higher on a test designed to measure higher order cognitive skills than students guided by a student tutor. Student tutors were rated no differently from staff tutors with respect to the way they stimulated learning processes, directed the discussion content and monitored the discussion process. It seems that in a quantitative way, staff tutors and student tutors behave more or less the same. Qualitatively, however, there may be differences in their behavior which the tutor functioning questionnaire is unable to tap. Interventions of staff tutors may be more to the point than those of student tutors due to the fact that they are experts in their fields.

Introduction

Law education at the University of Limburg (Maastricht, The Netherlands) features small-group tutorials alternating with periods of independent study. The problem-based learning method is the main instructional approach of this university. It is specifically designed to help students to acquire new information in more self-directed ways, to foster problem-solving skills and to enhance motivation and knowledge retention (Schmidt & De Volder, 1984). One of the cornerstones of this method is the small tutorial group, consisting of about ten students in which law cases are analyzed using students' prior knowledge. Learning goals are formulated by the students themselves for subsequent independent study aimed at improving their understanding. After two days of independent study the groups meet again to report and discuss their findings. The groups are guided by faculty tutors. Their primary role is to stimulate the group discussion and to facilitate students' learning processes in non-directive ways (Moust & Nuy, 1987).

The Faculty of Law decided to explore the possibility of assigning the role of tutor not only to staff members but also to undergraduate students. The main reasons for this were economic considerations: "Given today's high student-faculty ratios an increase of the number of teachers appears highly desirable. At a time of financial constraints, indeed of budgetary cuts, however, such a proposition would be totally unrealistic. In this context, it should

perhaps be underlined that peer teaching represents one of the few instructional innovations which does not call for an immediate additional investment" (Goldschmid & Goldschmid, 1976, p. 14).

Of course, using peer teaching raises the question whether student-led groups differ from teacher-led groups with respect to cognitive achievement. In their review of the literature, De Volder, de Grave and Gijselaers (1985) concluded that the results are inconclusive mainly due to the fact that studies suffered serious methodological shortcomings. In their own research, these authors compared tutor-led with teacher-led groups in three courses in the Faculty of Health Sciences. In two courses no significant differences were found while in a third course students in student-led groups scored significantly lower on a cognitive achievement test than students in teacher-led discussion groups. In the latter course, no significant mean differences in test scores were found between students taught by high-achieving student-teachers and students taught by average-achieving student-teachers. The most plausible explanation offered by De Volder *et al.* was that staff-teachers teach in more conventional ways, i.e. giving small-lectures, than student-teachers. Being in the advantage in terms of knowledge fund, this would have led to the better results of their students.

In a second study, de Grave, De Volder, Gijselaers and Damoiseaux (in press) focused on the effect of peer teaching on process and product variables by comparing student-teachers with staff-teachers with respect to teacher behavior, group functioning and test achievement of students. With respect to process variables the results indicated that staff-teachers showed more directive behaviors such as explaining matters on their own initiative and leading the discussion, while student-teachers acted more like "colleagues" and were more concerned about the motivational-emotional climate in the group. No significant difference in cognitive achievement was found. The presumed superiority of staff-teachers received no support in this study, at least with respect to tests of factual knowledge. This result was confirmed in a study by ten Cate (1986) who found no significant differences in three experiments comparing students' achievement on knowledge tests in small groups led by students versus by teachers. 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. Rummelhart and Norman (1978) suggest three qualitatively different kinds of learning: (a) *accretion*, or the encoding of new information in terms of existing schemata; (b) *restructuring or schema creation*, the process whereby new schemata are created; and (c) *tuning or schema evolution*, the slow modification and refinement of a schema as a result of using it in different situations. Norman (1978) suggests that accretion learning requires study and can be tested by conventional recall and recognition techniques. Restructuring on the other hand occurs as a result

of encountering examples, analogies, and metaphors, as well as through tutorial interactions such as Socratic dialogue. Tests of restructuring should include conceptual tests and questions that require inference or problem solving. Tuning is a process that is continuous over a lifetime of practice at the task. Tests of tuning should be measures of speed and smoothness, including performance under stress or pressure. In problem-based settings, as in the University of Limburg, we assume, most of the accretion takes place during independent study, while most restructuring occurs during the small groups meetings. As a consequence, it seems relevant to us to study the effect of peer teaching on learning outcomes of a higher cognitive level using tests that require inference and problem solving.

Method

Procedure

The Faculty of Law offers a four year program. The first year curriculum is divided in five block periods of six weeks, each devoted to an interdisciplinary theme within the field of law. Themes of the first year program, are, e.g., "rules and regulations", "agreements" and "unlawful behavior". Data were collected in the last block-period devoted to the topic of "law enforcement" in the academic year 1986–1987. Study topics in this block focused on Civil Law, Criminal Law and Administrative Law. During the block students meet in small-group tutorials twice a week in two hour sessions to discuss problems and to report on the information gathered during two day periods of independent study. Every group of 10 students was tutored by a staff member or a third or fourth year student. Before the academic year started undergraduate students were invited to become tutor. Fifteen students opted for this role. After a short selection procedure ten students were chosen. All these student-tutors received the same two-day tutor training as the staff-tutors and had to practice during the first year block period "Introduction to a problem-based law study" in which they were counseled by an experienced staff tutor.

Instruments

At the end of the block period all 205 students were asked to complete a questionnaire on tutor functioning consisting of 19 items. Ninety-five questionnaires were returned (response rate 46%). The item form was of the Likert type with rating scores between 1 (strongly disagree) to 5 (strongly

agree). The questionnaire consisted of three subscales. For each subscale a few examples of items are given.

(a) *stimulating the learning process* (5 items, alpha = 0.80).
Regularly the tutor asked questions that deepened our discussion.
The tutor stimulated a methodical approach of the cases.
The tutor had a good understanding of the difficulties we encountered.
(b) *directing the discussion content* (9 items, alpha = 0.82).
The tutor indicated what the main points were to be studied in this block.
On his/her own initiative the tutor explained certain matters exhaustively.
Often the tutor interrupted the discussion to make corrections.
Monitoring the discussion process (5 items, alpha = 0.75).
The tutor carefully saw to it that every group member had the opportunity to bring in his or her views.
Regularly the tutor evaluated the way we cooperated in the group.
The tutor asked for feedback on his/her own functioning.

At the end of the block all 205 students were required to take a summative test on the topic of the block. The block test offered the students a set of six questions of the essay format, from which each student had to select three questions to answer. Students were given two hours to answer the three questions they chose. The test was designed to measure more than just factual knowledge. By requiring use of concepts and principles and by stressing that a full argumentation in the answer is necessary, students are strongly encouraged to give answers that show insight and reasoning skills. This will be illustrated by two typical questions used:

(a) Mr. Vermeer owns a bar on Our Lady's Square in Maastricht. He applies for a licence, required under a local by-law, to operate a side-walk cafe. Mayor and Alderman of Maastricht grant the licence, but attach a condition to the effect that the area taken up by the sidewalk cafe, shall not exceed 80 square meters. After some time, a diligent police officer establishes that the cafe covers 84 square meters of the Our Lady's Square.
1. What measures can the municipal authorities take against Mr. Vermeer?
2. Discuss the legal options available to Mr. Vermeer to defend himself against each of the measures referred to under point 1.

(b) The "passivity" of the court is considered a fundamental principle of civil procedure.
1. With regard to which elements of a case can a civil court be said to be "passive"?
2. State two arguments for the proposition that the "passivity" of a civil court is not unlimited.

Answers were scored from 1 (very bad) to 10 (very good). The mean of the students' three scores is calculated and this score is further used in grading decisions. The test is passed with a score of six or more points.

Data analysis

Two conditions existed: students were either in a group tutored by a student or by a staff member. The three tutor functioning scale scores and the test achievement scores were analyzed by comparing the two conditions using a *t*-test for independent samples.

Results and discussion

The results are shown in Table 1. Students guided by a staff member scored significantly higher on a test designed to measure higher order cognitive skills than students guided by a student tutor. This seems to indicate that staff tutors are better able than student tutors to guide the modification and reorganization of knowledge (*restructuring* as defined by Rummelhart & Norman, 1978). An essential requirement of effective guidance is the way the tutor monitors the learning process. During the small group discussions the tutor has to diagnose students' misconceptions and inconsistencies in their existing cognitive schemata and recognize anomalies in their reasoning. As experts in their field, staff tutors possess more elaborated knowledge structures with respect to the specific area to be studied than student tutors. This could enable them to be more effective in guiding students' cognitive restructuring.

Table 1. Tutor ratings and test achievement (TEST) of students from student-led versus teacher-led discussion groups. Tutors are rated for stimulating learning processes (STIMUL), directing the content of the discussion (DIRECT), and monitoring the group discussion (MONITOR).

	STIMUL	DIRECT	MONITOR-	TEST
Student-led				
mean	21.1	29.7	14.7	5.4
s.d.	4.4	6.5	3.7	1.6
Teacher-led				
mean	20.1	28.8	13.6	6.1
s.d.	4.9	9.7	5.0	1.6
t-value	1.14	0.56	1.30	3.03
d.f.	93	93	93	203
p (2-tailed)	0.26	0.58	0.20	0.00

However, we found no significant differences in tutor behavior as measured by the three tutor functioning scales between staff tutors and student tutors. Student tutors were rated no differently from staff tutors with respect to the way they stimulated learning processes, directed the discussion content and

monitored the discussion process. It seems that in a quantitative way, staff tutors and student tutors behave more or less the same. Qualitatively, however, there may be differences in behavior which the tutor functioning questionnaire is unable to tap. Interventions of staff tutors may be more to the point than those of student tutors due to the fact that they are experts in their fields.

This effect could be strengthened when students perceive the contributions of staff tutors as more worthwhile than those of student tutors. Students' perceptions of the contributions of the tutor and consequently their effects on students' learning behavior could be influenced by the authority the tutor possesses. According to Peters (1966) the authority of teachers is two-sided: it derives from their expertise and from their formal status in the organisation. It seems reasonable to assume that students ascribe more authority to staff tutors than to student tutors. This could mean that staff interventions, although not more frequent than those of student tutors, have more impact.

In conclusion, our study seems to indicate that staff tutors are better able than student tutors to stimulate higher order learning processes in students during small group discussions. The way they accomplish this is not easily detected by questionnaire ratings of tutor behavior. Interviews, observations and stimulated recall using videotaped group discussions could shed more light on the complex learning processes in small group work.

References

Cate, Th. J. ten (1986). *Leren in groepen zonder docent (Learning in Teacherless Groups.* University of Amsterdam: Unpublished doctoral dissertation.

Cornwall, M.G. (1979). *Students as Teachers: Peer Teaching in Higher Education.* University of Amsterdam: C.O.W.O.

De Volder, M.L., de Grave, W.S. & Gijselaers, W.H. (1985). 'Peer teaching: Academic achievement of teacher-led versus student-led discussion groups', *Higher Education, 14,* 643–650.

Grave, de, W.S., De Volder, M.L., Gijselaers, W.H. & Damoiseaux, V. (in press). 'Peer teaching and problem-based learning: Tutor characteristics, group functioning and student achievement', in: Schmidt, H.G., Lipkin Jr., M., de Vries, M.W. & Greep, J.M. (eds.), *Education for Tomorrow's Medicine Today.* New York: Springer.

Goldschmid, B. & Goldschmid, M.L. (1976). 'Peer teaching in higher education: A review', *Higher Education, 5,* 9–33.

Moust, J.H.C. & Nuy, H.J.P. (1987). 'Preparing teachers for a problem-based student-centered law course', *The Journal of Professional Legal Education, 5,* 16–31.

Norman, D.A. (1978). 'Notes toward a theory of complex learning', in: A.M. Lesgold, J.W. Pellegrino, S.D. Fokkema & R. Glaser (eds.), *Cognitive Psychology and Instruction.* New York: Plenum Press.

Peters, R.J. (1966). *Ethics and Education.* London: Allen and Urwin.

Rummelhart, D.E. & Norman, D.A. (1978). 'Accretion, tuning and restructuring: Three modes of learning', in J.W. Cotton & R.L. Klatzky (eds.), *Semantic Factors in Cognition.* Hillsdale, N.J.: Lawrence Erlbaum Associates.

Schmidt, H.G. & De Volder, M.L. (eds.) (1984). *Tutorials in Problem-Based Learning.* Assen, The Netherlands: Van Gorcum.