The impact of student-generated learning issues on individual study time and academic achievement*

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Objectives The aim of this study was twofold. The first question concerns the way students make use of the learning issues they generate (as strict guidelines or as global guidelines) and whether this changes across years of training. The second question concerned the relationship between the way students make use of learning issues and the time spent on individual study and achievement on two tests of knowledge.

Design A questionnaire was developed, containing seven items that measured to what extent students study strictly according to the student-generated learning issues and six items that measured to what extent students study beyond the student-generated learning issues. The questionnaire also contained one question in which students had to estimate the mean time spent on individual study. Achievement was measured by two forms of tests of knowledge, a block test assessing course content and a progress test assessing long-term functional knowledge.

Setting Medical School of Maastricht University, the Netherlands.

Subjects Medical students (response = 69%) from the problem-based curriculum at the Maastricht University.

Results During their first year students study strictly according to the content of the learning issues, whereas in later years students studied more according to their own learning needs and interests. In addition, students who tended to study beyond the generated learning issues spent more time on individual study and achieved better on both tests.

Conclusions Students in a problem-based curriculum seem to become better self-directed learners during the years of training.

Keywords *Education, medical, undergraduate; learning; The Netherlands; *problem-based learning; questionnaires.

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Introduction

In problem-based learning (PBL) students are encouraged to take substantial responsibility for their own learning. Independent and active learning is stimulated by discussing problems in small groups.[1] A problem consists of a description of a set of phenomena needing some kind of explanation. The discussion provides unanswered questions which subsequently serve as a guide for independent and self-directed learning.[2] These questions are called student-generated learning issues and are described by Blumberg and colleagues[3] as factual or conceptual topics that each group decides must be better understood in order to analyse adequately the problem under discussion. Student-generated learning issues are an essential starting-point for students' individual study and it is assumed that they play an important role in students' development of self-directed learning.[4] According to Knowles,[5] self-directed learning can be seen as a process in which individuals take the initiative with or without the help of others in diagnosing their learning needs, formulating learning goals, identifying human and material resources, choosing and implementing appropriate learning strategies and evaluating learning outcomes.

Some evidence for self-directed learning behaviour in PBL was found in a study by Blumberg and Michael.[6] They found that PBL students used more resource materials than students in a conventional curriculum. Similarly, in a study at self-directed learning skills of first-year students in a PBL curriculum, Dwyer[7] found that at the end of the first year students were feeling

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very encouraged to identify learning needs, and were more motivated to identify resources, compared to the beginning of the year. Ryan[8] studied students' perceptions about their self-directed learning skills. Students who were enrolled in a course which implemented PBL filled in a questionnaire. The students seemed to change their perception of the importance of self-directed learning. At the end of the year they had a more positive perception of their ability as self-directed learners. Therefore, it seems that when students are responsible for their own learning they acquire autonomous learning skills and learn to be better self-directed learners as they progress through their studies.

In PBL student-generated learning issues play an important role in this process. In a study by Dolmans and Schmidt,[9] indirect evidence was found for this relationship. They focused on the extent to which various elements of a problem-based curriculum influence students' decisions as to what to study. It was found that not only student-generated learning issues, but also other elements may have an impact on students' study decisions. These elements were literature cited in the reference list, content covered in lectures and tests. The influence of these elements tended to decrease over the 4 curriculum years. The influence of generated learning issues, on the contrary, tended to increase over the 4 years. It was concluded that students in a problem-based curriculum become more accomplished self-directed learners.

The extent to which students use learning issues to define the content of individual study is a process that can differ between students. Because PBL students are highly responsible for their own learning first- and second-year students, who are not yet experienced self-directed learners, are consequently expected to rely more strongly on the learning issues formulated. With more seniority, students are expected to become better self-directed learners. This would imply that they will be better able to identify their needs and to follow their own interests during their individual study.

Thus, it is expected that students in a problem-based curriculum during the first curriculum years will use learning issues step by step as strict guidelines to study the literature, whereas in later years they will use learning issues as global guidelines that fit their individual needs and interests better. The aim of this study was, first of all, to test this hypothesis and to find out whether there are differences between the years of training. If students in the higher curriculum years show increased use of learning issues as global guidelines and rely more on their own needs and interests, this might indicate that students become better self-directed learners.

A follow-up question addressed in this study was whether students who used learning issues more as global guidelines that fit their personal needs and interests would spend more time on individual study. In a problem-based curriculum, scheduled activities (tutorial groups, lectures, skills training, etc.) are kept to a minimum per week to provide ample time for individual study.[10] It was expected that students who studied beyond the learning issues generated would spend more time on individual study. In addition, it was expected that students with this learning approach would achieve better in tests. The examination system in a problem-based curriculum, such as the one under investigation, is aimed at rewarding extra learning activities during individual study and at avoiding test-driven study behaviour.[11]

In summary, two questions are dealt with in this study. First, in which way do students make use of the generated learning issues (as strict guidelines or as global guidelines) and is there a difference according to year of training? Secondly, how does the use of generated learning issues relate to time spent on individual study and achievement on tests of knowledge?

Method

Materials

The study was conducted at the problem-based Medical School of Maastricht University in the Netherlands, during the academic year 1995–96. Prior to the construction of a questionnaire, 12 students were interviewed to gain more insight into whether and to what extent learning issues play a role during individual study. Based on these responses a questionnaire was developed. In this questionnaire seven items assessed the extent to which students study strictly according to the student-generated learning issues (learning issue restrictive approach) and six items measured the extent to which students study beyond the student-generated learning issues (learning issue broadening approach). The first dimension (learning issue restrictive approach) reflects the use of learning issues as items that need to be answered step by step. The second dimension (learning issue broadening approach) reflects the extent to which students follow their own interest and their individual learning needs. The items of both dimensions are shown in Table 1. Students were asked to give their opinion on each item using a five-point Likert scale ranging from (1) totally disagree to (5) totally agree.

To assess construct validity of the two dimensions, a confirmatory factor analyses was performed.[12] The

Table 1 Seven items of the questionnaire measuring the learning issue restrictive approach and six items measuring the learning issue broadening approach

Items of dimension 'learning issue restrictive'	Items of dimension 'learning issue broadening'
During my inidividual study I use learning issues as a ...	• When I am absent in the tutorial group, I formulate my own learning issues
• guideline to determine what literature I'm going to study	• I choose literature on the basis of my interest, regardless of whether it is important for the block-content
• check to see if the literature I have studied covers the content	• I often formulate my own learning issues
• guideline to determine to what depth I must study certain topic	• I study more broadly than what is only necessary to answer
• guideline to mark out the subject matter	• When my individual study is restricted to the learning issues, I am afraid I will have gaps in my knowledge
• guideline to study literature step-by-step	• During my individual study I always try to integrate different topics
• guideline to distinguish main topics and side topics	
During individual study I am guided by ...	
• the learning issues generated in the tutorial group	

results showed a chi-square value of 217·75 (d.f. = 64, $N = 479$), $P < 0{\cdot}0001$, an adjusted goodness-of-fit index (AGFI) of 0·89 and a root mean square residual (RMSR) of 0·06. The constraints as defined by Saris and Stronkhorst[13] are met, such that the data are assumed to fit the two dimensions reasonably.

Further, the questionnaire contained one additional question in which students had to estimate the mean time they spent on individual study per week. A study by van Til and colleagues[14] showed that this method provides a reasonably reliable indicator of time spent on individual study.

Academic achievement was measured by using the scores on two different forms of tests. The first type was the block test. In general the block test, administered after each block, reflects the content of the foregoing block of 6 weeks. The major goal is to assess students' knowledge about the block contents and to provide the students with information on their achievement in relation to the course objectives. Each test is composed of 160–190 questions in the true/false format with an 'I don't know' option (the question-mark option). Students are required to complete the block-test immediately after the end of each 6-week block. A correct answer scores plus one, with an incorrect answer scoring minus one. The question mark scores zero. The overall score is the correct minus incorrect score and is expressed on a percentage scale.

The other test is the progress test. All students of every year of training are required to take the progress test, a comprehensive test at graduate level, sampled from the total body of medical knowledge, four times a year.[11] Students cannot prepare themselves for the progress test and it therefore rewards the individual non-test-directed study activities of students. Each test consists of approximately 250 true/false items with a question mark option, with scores expressed similarly to the block test.

Procedure

The questionnaire was administered to all fourth-year students (the Maastricht programme is a 6-year training programme) at the end of the academic year 1995–96.

For each student a mean score was computed across the items measuring both dimensions (learning issue restrictive approach and learning issue broadening approach). To facilitate the interpretation of the data the mean scores were categorized into three groups: the lowest group (score lower than 3), a middle group (score between 3 and 4) and the highest group (score higher than 4). For each group the mean time spent on individual study was calculated. Block-test scores were transformed into Z-scores per year and averaged across all seven tests of that year. The same procedure was followed with scores from all four progress tests in each year of training.

Differences between students' scores in each dimension on the hours spent on individual study and the test-score were analysed using ANCOVA with years of training as a covariate. Specific differences across the years of training were analysed with *post-hoc* analyses using Scheffé's *F*-test.

Results

In total 479 students filled in the questionnaire (response 69%). In the first year the response rate was 73% (n = 156), in the second year 72% (n = 149), in the third year 72% (n = 101) and in the fourth year 55% (n = 73).

Results in Table 2 show that the score on the first dimension (learning issue restrictive approach) was highest among first-year students and lowest in the third and fourth year. These scores differ significantly [$F(3, 468) = 7{\cdot}19$, $P < 0{\cdot}0001$], i.e. the mean score of the first-year students differs significantly from those of the third- and the fourth-year students.

Table 2 Mean scores on the dimensions (mean), standard deviation (SD), number of students (N) for the total group and per year

	Learning issue restrictive approach			Learning issue broadening approach		
	Mean	SD	N	Mean	SD	N
Year 1	3·7	0·6	151	3·1	0·6	151
Year 2	3·6	0·6	145	3·4	0·6	144
Year 3	3·4	0·7	101	3·4	0·8	101
Year 4	3·4	0·7	74	3·5	0·7	74
Total group	3·6	0·7	471	3·3	0·7	470

Table 2 also shows that for the second dimension (learning issue broadening approach) students score lowest in the first year and highest in the fourth year. The scores between years differ significantly on this dimension [$F(3, 467) = 5{\cdot}81$, $P < 0{\cdot}001$]; that is, the first-year students differ significantly from the second-, third- and fourth-year students.

Table 3 gives the mean time spent on individual study for three groups: students scoring in the low, middle and high ranges on each dimension. The three groups in the dimension 'learning issue restrictive' do not differ significantly on the hours spent in individual study [$F(2, 385) = 0{\cdot}90$, $P > 0{\cdot}40$]. For the dimension 'learning issue broadening' groups differ significantly on hours spent in individual study [$F(2, 384) = 10{\cdot}80$, $P < 0{\cdot}001$]. These differences cannot be explained by years of training [$F(1, 378) = 1{\cdot}38$, $P > 0{\cdot}24$]. In all years the students with the highest score on this dimension reported the most time spent on individual study and students with the lowest score on this dimension reported the least time. Tables 4 and 5 contain the mean block-test and progress-test scores for each group in each dimension. Table 4 indicates that groups in the first dimension (learning issue restrictive approach) differ in their block-test scores. A trend is shown that the more students study strictly according to the learning issues, the lower their score on the block-test. However, these differences are not significant [$F(2, 464) = 2{\cdot}20$, $P > 0{\cdot}11$]. The groups categorized on the second dimension (learning issue broadening approach) differ significantly on the block test [$F(2, 465) = 5{\cdot}81$, $P < 0{\cdot}001$].

No significant effect for years of training [$F(2, 465) = 0{\cdot}10$, $P > 0{\cdot}74$] was found. The scores on the block test are higher when students have higher scores on the dimension. In other words, the more students

Table 3 Mean hours spent on individual study (mean), standard deviation (SD), number of students in each group (N) for both dimensions (learning issue restrictive approach and learning issue broadening approach), split up for students scoring low (< 3), middle (3–4), and high (> 4) on each dimension

	Learning issue restrictive									Learning issue broadening								
	Low			Middle			High			Low			Middle			High		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Year 1	14	6	13	15	8	59	16	6	53	14	6	39	16	8	68	19	9	18
Year 2	22	6	15	18	7	58	19	6	38	16	6	26	18	7	64	24	8	22
Year 3	16	8	21	16	8	47	20	8	19	15	5	25	18	9	41	18	8	21
Year 4	20	8	16	18	6	32	17	7	16	14	9	17	19	6	34	20	8	21
Total	18	8	65	17	7	196	18	7	126	15	6	107	17	7	207	20	9	82

Table 4 Mean *Z*-scores on block-test (mean), standard deviation (SD), number of students in each group (*N*) for both dimensions (learning issue restrictive approach and learning issue broadening approach), split up for students scoring low (< 3), middle (3–4) and high (> 4) on each dimension

	Learning issue restrictive									Learning issue broadening								
	Low			Middle			High			Low			Middle			High		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
Year 1	0·09	0·8	17	0·14	1·0	74	−0·18	1·0	59	−0·27	1·0	45	0·13	0·9	84	0·15	1·0	17
Year 2	0·39	0·4	19	0·05	0·9	71	−0·23	1·0	42	−0·30	0·8	29	−0·02	1·0	75	0·33	1·0	29
Year 3	−0·21	1·0	28	0·08	0·9	57	0·03	1·2	21	−0·06	1·0	31	0·06	1·0	47	−0·03	1·0	27
Year 4	0·24	1·1	19	−0·13	0·9	39	−0·10	0·7	19	−0·37	0·9	19	0·08	0·9	37	0·16	1·0	24
Total	0·13	1·1	83	0·04	0·9	241	−0·13	1·0	141	−0·24	0·9	124	0·06	0·9	243	0·16	1·0	97

Table 5 Mean *Z*-scores on progress-test (mean), standard deviation (SD), number of students in each group (*N*) for both dimensions (i.e. learning issue restrictive approach and learning issue broadening approach), split up for students scoring low (< 3), middle (3–4) and high (> 4) on each dimension

	Learning issue restrictive									Learning issue broadening								
	Low			Middle			High			Low			Middle			High		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
Year 1	0·17	0·8	17	0·02	1·0	74	−0·03	0·9	59	−0·12	0·8	45	0·06	1·0	84	0·06	1·3	17
Year 2	0·51	1·4	19	−0·02	0·8	71	−0·18	0·9	42	−0·19	0·8	29	−0·10	1·0	73	0·49	1·3	29
Year 3	0·08	1·0	28	−0·05	0·8	57	0·53	1·2	22	−0·07	0·8	33	−0·03	0·8	47	0·16	1·1	27
Year 4	0·31	1·1	19	−0·13	1·0	39	−0·05	0·5	19	−0·24	0·6	20	0·06	1·0	39	0·08	1·2	24
Total	0·26	1·1	83	−0·04	0·9	241	0·06	0·9	142	−0·14	1·8	127	−0·01	0·9	243	0·23	1·2	97

study by going beyond the learning issues, the higher their score on the block test.

In Table 5 the results for the progress test are shown, indicating that the three groups specified in the first dimension (learning issue restrictive approach) differ on the scores on the progress test.

These differences are significant [$F(2, 463) = 5{\cdot}60$, $P < 0{\cdot}001$]. No significant effect for years of training [$F(2, 463) = 0{\cdot}51$, $P > 0{\cdot}47$] was found. Students who reported low on this dimension have higher scores in the test, whereas students who reported high on this dimension have low scores in the progress test. Groups in the second dimension (learning issue broadening approach) also differ significantly in the progress test [$F(2, 465) = 7{\cdot}90$, $P < 0{\cdot}001$]. There was no significant effect for years of training [$F(2, 465) = 0{\cdot}29$, $P > 0{\cdot}59$]. Students who reported high on this dimension have also higher scores in the progress test compared to students who reported low.

Discussion and conclusion

The first aim of this study was to answer the question of to what extent students restrict themselves to the learning issues generated in the tutorial group and to what extent they go beyond the learning issues. The first conclusion of this study is that first-year students, in particular, use learning issues in a different way from students in the senior years. First-year students confine themselves more strictly to the content of learning issues and use a more learning-issue restrictive approach. This implies that they are answering them step by step, using them as a tool to demarcate the literature. In later years students study more according to their own learning needs and interests, use a more learning issue broadening approach, and study not only according to topics related directly to the learning issues generated. A possible explanation is that students in the first year are uncertain about what literature

should be studied. Senior students probably feel better able to determine independently what to study, may have more knowledge about the vast number of information resources available, may have better information-seeking skills, may be better at self-monitoring and may be more efficient about their time allocation. Thus, students seem to become better self-directed learners during the years of training. A theory from Vermunt[15] states that when students are able to regulate their own learning process and when the instruction programme is not heavily externally regulated, there is no friction in the learning process of students. Perhaps students in later years need less external regulation and therefore are more likely to go beyond the learning issues generated and are better able to regulate their own learning needs than first-year students.

However, two problems can bias the interpretation of the results. First, only half the students in the fourth year responded (55%). It might be possible that the questionnaires have been completed by more motivated students, who might also be the ones who study widely and do better in tests. However in the third year, in which 72% of all students completed the questionnaire, the results show a very similar pattern to the fourth-year students. A second bias might be that data were not gathered longitudinally, due to which differences between years of training can still be explained by differences in student population across the years of training.

Another explanation of the fact that students in later years study more beyond the learning issues might be that the quality of the student-generated learning issues decreases during years of training. In the interviews taken with three students in each year, students in their third and fourth year mentioned that the tutorial groups were sometimes less functional than in their first and second years. This could have a negative impact on the learning issues generated and students would then be forced to determine for themselves what is important to study. However, in the same interviews students in each year reported that learning issues were an important starting-point for individual study and were very useful to this end. Further research is needed to clarify this issue.

The second aim of this study was to explore the relation between the use of learning issues and the time spent on individual study and achievement. The results showed that students who go beyond the learning issues spend more time on individual study and also achieve better on tests of knowledge. It seems that when students are developing themselves as self-directed learners, in PBL this method of learning will be rewarded. This is important because the 'learning issue broadening' dimension implies that these students focus on relevant issues and not on irrelevant ones, otherwise they were unlikely to do better in knowledge tests.

Thus, students achieve better and may have a better understanding of the issues when they study more than what is directly related to the learning issues. Therefore students must be stimulated to study beyond the learning issues and develop the skills to be able to determine independently what the relevant issues are for their individual study. A decrease over the years of training in the learning issue restricted approach and an increase in the learning issue broadening approach might indicate that both approaches are likely to be inverse. However, both approaches can still be complementary instead of inversely related because students can use a combination of both approaches, i.e. using learning issues as strict guidelines but also broadening their study.

An alternative explanation might be that students who go beyond the learning issues are more test-driven instead of being better aware of a certain lack in their medical knowledge. They spend more time on studying certain topics for better understanding of the materials that are tested instead of satisfying their own learning needs. Pure test-driven learning could be rewarded by the block test but not by the progress test. However, the effects were similar for both tests. A remedial approach, checking blank spots and studying systematically, might, however, be considered as an important self-directed learning skill.

References

1 Barrows HS, Tamblyn RM. *Problem-Based Learning: an Approach to Medical Education.* New York: Springer Publishing Company; 1980.

2 Schmidt HG. Problem-based learning: rationale and description. *Med Educ* 1983;17:11–6.

3 Blumberg P, Michael JA, Zeitz H. Roles of student-generated learning issues in problem-based learning. *Teaching Learning Med* 1990;2:149–54.

4 Walton HJ, Matthews MB. Essentials of problem-based learning. *Med Educ* 1989;3:542–58.

5 Knowles MS. *Self-Directed Learning: a Guide for Learners and Teachers.* New York: Cambridge Books; 1975.

6 Blumberg P, Michael JA. Development of self-directed learning behaviours in a partially teacher-directed problem-based learning curriculum. *Teaching Learning Med* 1992;4:3–8.

7 Dwyer J. Predicting self-directed learning readiness: a problem or not?. In: Ryan G, editor. *Research and Development in Problem-Based Learning.* Sydney: Macarthur; 1993.

8 Ryan G. Student perceptions about self-directed learning in a professional course implementing problem-based learning. *Stud Higher Educ* 1993;18:53–63.

9 Dolmans DHJM, Schmidt HG. What drives the student in problem-based learning? *Med Educ* 1994;28:372–80.

10 Gijselaers WH, Schmidt HG. Effects of quantity of instruction on time spent on learning and achievement. *Educ Res Eval* 1995;**1**:183–201.
11 Vleuten CPM, Verwijnen GM, Wijnen WHFW. Fifteen years of experience with progress-testing in a problem-based curriculum. *Med Teacher* 1996;**18**:103–9.
12 Arbuckle JL. *Amos users' guide*, Version 3.6. Chicago: Smallwaters Corporation; 1997.
13 Saris WE, Stronkhorst LH. *Causal Modelling in Non-Experimental Research*. Amsterdam: Sociometric Research Foundation; 1984.
14 Til CT, Vleuten CPM, van der & Berkel HJM. Invloed van regelmaat van studeren binnen PGO op de studieresultaten van studenten [Influence of regularity of studying in a problem-based curriculum on students' achievement]. In: Smal JA, editor. *GOC-Proceedings*. Houten: Bohn Stafleu Van Loghum; 1997.
15 Vermunt JDHM. Process-oriented instruction in learning and thinking strategies. *Eur J Psychol Educ* 1995;**10**:325–49.

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