CHAPTER 9

Construction of Problems for Problem-Based Learning

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The cognitive achievement of students of medical schools employing problem-based learning (PBL) depends mainly on knowledge gained in the course of elaborating on written problems presented within the curriculum and on knowledge gathered as a side product of practical training. The undergraduate curriculum of Maastricht Medical School was set up about 10 years ago, stemming from the idea that presentation of a large set of patients' problems that are frequently encountered by general practitioners would equip students with appropriate basic and medical knowledge. Unfortunately, this concept turned out to be somewhat naive. Confronted with patients' problems, many students were apparently motivated in such a manner that they adapted the role of physician: They were anxious to establish the diagnosis and subsequently focused their study activities on the therapy of

that particular disease. However, the study of the etiology of the disease and its underlying basic mechanisms was frequently avoided. Other students were truly driven by the patients' problems to study basic mechanisms, but they seldom extended their investigations as far as was intended by the staff: for example, cell biology, biochemistry, and biophysics were rarely studied thoroughly. A third category of students focused on just one detail of the problem that was most appealing to them. That particular aspect of the problem was studied in depth but, probably due to lack of time, all other aspects were neglected.

Staff designers of problems tried to unify the diverse study policies of students described above in order to improve matching with their educational objectives. Thus, for example, more or less extensive lists of questions, key words, or references to textbooks were added to the problems. Other approaches included introducing the problems presented in the context of a certain theme by means of comprehensive information pertaining to that theme or by offering a long list of highly detailed learning objectives. It is clear that curriculum-phase books constructed along these lines were impracticable for use in small learning groups, for which exchange of preexisting knowledge and formulation of hypotheses by free association were recommended as essential steps in the problem-based learning process (Schmidt, 1982).

In this chapter, a format for presentation of problems has been worked out that which was supposed to improve matching of the students' study activities to the educational objectives specified by the faculty. Evaluation of this format was accomplished by means of questionnaires propounded to students and to the faculty who were involved in the small learning groups (tutors). Particularly, the observation of the tutors that good matching existed between the students' study activities and the specific educational objectives was taken as an indication that this approach deserves more widespread application and further evaluation.

METHODS

We have sought to improve matching between student's study activities and the faculty's educational objectives in the following manner. First, a theme was selected that would sustain specification of relevant educational objectives over a wide range of disciplines, including those easily ignored by the students. In fact,

influenza (flu) was chosen as a theme for this study. Second, faculty resource persons from several relevant disciplines were each invited to produce an extensive list of topics judged by them as indispensable for students in order to comprehend the selected theme. Each of the lists produced in this way represented the cores of learning objectives of one discipline for that theme.

Next, the topics specified by the individual resource persons

TABLE 9.1 Questionnaire: Students' Evaluations of the "Flu" Block

Statements	*Mean scores*[a]		
	Medical students ($n=95$)	*Health sciences students* ($n=95$)	p[b]
1. Working was pleasant	1.6	2.0	$\leqslant .05$
2. As a whole, it was interesting	1.5	2.0	$\leqslant .01$
3. Problems and tasks were clearly interrelated	2.0	1.7	
4. Format was too structured	3.2	3.3	
5. Problems were suitable for systematical approach by small groups		2.0	2.3
6. I feel confident of my knowledge of the biological aspects of influenza	2.9	2.2	$\leqslant .001$
7. I feel confident of my knowledge of the epidemiological and social aspects of influenza of influenza	2.9	2.3	$\leqslant .001$
8. I recognized the importance of the tasks covering biological aspects of influenza	2.2	2.7	$\leqslant .05$
9. I am concerned that certain aspects of flu have not been covered	2.6	3.2	$\leqslant .01$

[a]Answers to statements were scored on a 5-point scale: 1 = full agreement; 2 = agreement; 3 = neutral; 4 = disagreement; 5 = full disagreement.
[b]*p* values were calculated by Student's *t*-test.

were rearranged in a hierarchic manner. In this fashion, a "topic tree" was created, each branch of which encompassed a cluster of interrelated items. In the following step, tasks were constructed, that each one of which was to cover one topic or cluster of topics. Before translating the topics into problems, however, we redefined the criteria that problems to be used in a problem-based curriculum should meet. The four criteria applied are been listed and annotated below. The final set of tasks and problems covering the theme was incorporated in the curriculum without special instructions for students and tutors. Tasks and problems were studied in small learning groups that were accompanied by a tutor, according to procedures described previously (Schmidt, 1983).

At the end of the curriculum phase in which the set of problems was used, students and tutors were asked to complete a questionnaire. Nine questions propounded to the students covered their pleasure and interest while working on the problems, their opinions regarding the structure of the entire set of problems and its suitability for analysis in small groups, their confidence on knowledge gathered, and their judgment of the relevance of some topics studied. The questionnaire is given in full in Table 9.1. Each item was presented as a statement that could be rated on a 5-point scale on which 1 = complete agreement, 2 = agreement, 3 = neutral, 4 = disagreement and 5 = complete disagreement. A questionnaire of the same format was propounded to the tutors. Eight questions covered the observed enthusiasm of students, the tutor's opinion of the structure of the entire set of problems and its suitability for analysis in small learning groups, freedom of learning versus (over) guidance by the set of tasks, level of knowledge gathered by the students, coverage of educational objectives, and applicability of this format throughout the curriculum. The questionnaire is given in full in Table 9.2.

CRITERIA APPLIED TO CONSTRUCTION OF PROBLEMS

Problems to be designed for use in PBL should fulfil the following criteria:

1. A problem should match the students' level of knowledge previously acquired. Reactivation of existing knowledge is considered an important advantage of the problem-solving process

TABLE 9.2 Questionnaire: Tutors' Evaluations of "Flu"

Statements	*Mean*[a]
1. Students worked with enthusiasm	1.9
2. Format was too structured	3.2
3. Problems were suitable for systematic approach by small groups	2.3
4. In general, students' learning objectives matched items of the topic tree	2.2
5. Some of the students' learning objectives were remote from the items of the topic tree	4.1
6. Students were free to select their own learning objectives, although the tasks and problems guided their study activities	2.5
7. In my opinion, students studied all aspects of influenza to an adequate level	2.4
8. The format of flu should be propagated for use throughout the undergraduate curriculum	2.7

[a]The 5 points of the scale represent the following opinions: 1 = full agreement; 2 = agreement; 3 = neutral; 4 = disagreement; 5 = full disagreement.

(Schmidt, 1982). Hence, the students should be familiar with part of the knowledge necessary for tackling the problem.

2. A problem should motivate students for further study activities. For this purpose, tasks should be concretely formulated and preferably show clear linkage to the students' future professions.

3. A problem should be suitable for the process of analysis to be applied. If the problem is to be presented to students for analysis in small learning groups, the problem should be formulated so that they are open enough to sustain discussion about possible solutions. Brief problems are more suitable for treatment in small learning groups than are elaborate descriptions.

4. A problem should direct the students inevitably to confrontation with one (or more) or the faculty's educational objectives.

As argued at the beginning of this chapter, developing a strategy to meet this requirement was one of the main goals of this study. An example of the strategy outlined here is presented in the following section.

THE FLU: PROBLEMS RANGING FROM THE MOLECULAR TO THE SOCIETAL LEVEL

It seemed appropriate that within a given theme ("flu" was chosen to work out as an example) resource persons from relevant disciplines should define their educational objectives. The resource persons were requested to attune their objectives to the level of the students, in this case first-year medical students. For

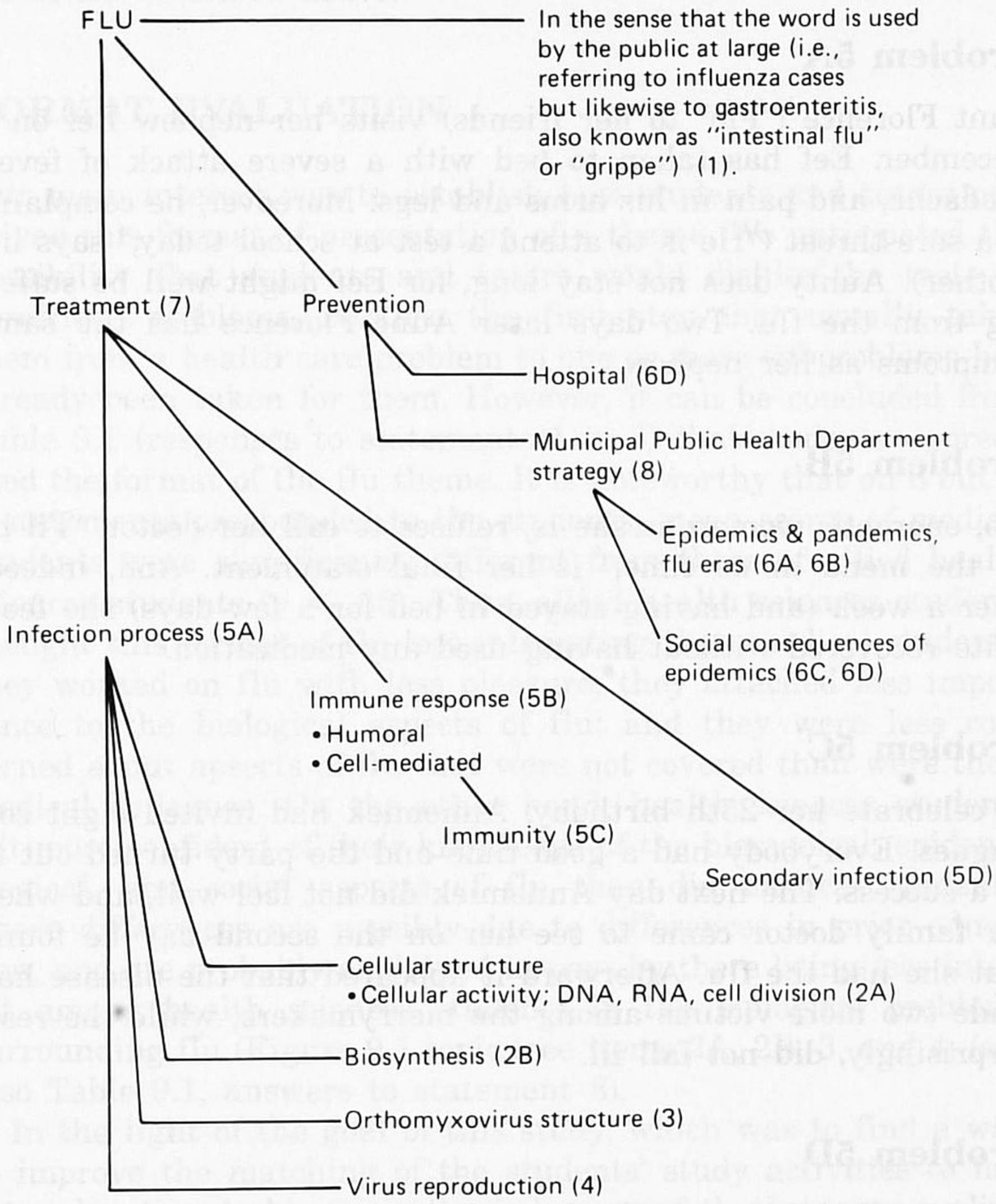

FIGURE 9.1 Topic tree designed for influenza (for 1st year undergraduate students). Codes in parentheses refer to the tasks that had to be performed by the students.

the flu theme, a virologist, a cell biologist, an immunologist, a physician, and an epidemiologist were asked to make an inventory of essential items. Topics provided by them were finally arranged in a topic-tree to exclude overlap of items and to create clusters of items from which educational objectives could be derived (Figure 9.1). In the next step, problems were designed to cover each topic. As an example, the problems covering cluster 5 (infection process, immune response, immunity, and secondary infection) are given below:

Problem 5A

Aunt Florence ("Flo" to her friends) visits her nephew Eef on 2 December. Eef has taken to bed with a severe attack of fever, headache, and pain in his arms and legs. Moreover, he complains of a sore throat ("He is to attend a test at school today," says his mother). Aunty does not stay long, for Eef might well be suffering from the flu. Two days later Aunt Florence has the same symptoms as her nephew.

Problem 5B

Flo, energetic woman as she is, refuses to call her doctor. "I'll be on the mend in no time," is her final statement. And, indeed, after a week (and having stayed in bed for a few days) she feels quite recovered without having used any medication.

Problem 5C

To celebrate her 25th birthday, Annemiek had invited eight colleagues. Everybody had a good time and the party turned out to be a success. The next day Annemiek did not feel well, and when her family doctor came to see her on the second day he found that she had the flu. Afterward it appeared that the disease had made two more victims among the merrymakers, while the rest, surprisingly, did not fall ill.

Problem 5D

People suffering from boils (furuncles) are sometimes advised—in the face of an oncoming influenza epidemic—to have themselves vaccinated against flu. Members of their families are advised accordingly.

The complete set of problems around the theme of flu was presented at the end of the very first (introductory) block for both medical and health sciences students. Working from the designated problems, 18 small learning groups (each encompassing about 10 students from both schools and a staff tutor) defined learning goals for self-study activities in sessions of 2 hours each. Two to 3 weeks were available for studying flu, so a total of four to six learning-group sessions were devoted to this subject. The evaluation data presented in the next section refer to the example of flu described above.

FORMAT EVALUATION

Our main interest was to establish how students and tutors perceived this format of presentation of a theme. We anticipated the possibility that students and tutors would dislike the taste of "prefried" problems, because the first step that usually takes them from a health care problem to one or more subproblems had already been taken for them. However, it can be concluded from Table 9.1 (responses to statements 1 to 5) that students appreciated the format of the flu theme. It is noteworthy that on 6 out of 9 statements propounded to the students, mean scores of medical students were significantly different from those of allied health sciences students ($p \leqslant .05$). Thus, allied health sciences students thought this format of flu less interesting than medical students; they worked on flu with less pleasure; they attached less importance to the biological aspects of flu; and they were less concerned about apsects of flu that were not covered than were their medical collegues. On the other hand, health sciences students felt more confident of their knowledge of the biomedical, epidemiological, and social aspects of flu than did medical students. These differences are possibly due to differences in prior education, and are probably explained in part by there being less interest among health sciences students in the biological problems surrounding flu (Figure 9.1 topic tree items 2A, 2B, 3, and 4; (see also Table 9.1, answers to statement 8).

In the light of the goal of this study, which was to find a way to improve the matching of the students' study activities to faculty educational objectives, the judgment of the tutors regarding the flu theme was of utmost importance. As shown in Table 9.2, the scoring of the tutors in response to statement 4 indicates that, in the opinion of 16 out of 19 tutors, the learning objectives

derived by the students from the problems satisfactorily matched the items of the topic tree. Moreover, only 3 tutors had observed that students selected learning objectives that were not related to items of the topic tree (statement 5). In general, the responses of the tutors to the other statements of the questionnaire showed no counterindication for the use of this format but, on the contrary, were often supporting it. Hence, we conclude that presenting a theme in a medical problem-based curriculum may benefit from prior design of a topic tree and the creation of tasks or small problems covering the individual items. Further experiments will be necessary to establish the advantages of the format suggested by the present study.

REFERENCES

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