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Problem-based learning: An introduction

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This Special Issue of Instructional Science contains a collection of papers around a common theme: Problem-based learning. Problem-based learning can be characterized as follows: A collection of carefully constructed and engaging 'problems' is presented to small groups of students. These problems usually consist of a description of a set of observable phenomena, situations, or events. In medical education for instance, these problems often take the form of a description of a patient, presenting a complaint with a number of signs and symptoms. In science education, the problem may consist of the description of the behavior of a block of wood on an inclined plane. The task of the group is to discuss these problems and elaborate on tentative explanations for the phenomena in terms of some underlying process, principle or mechanism. Virtually any event or set of phenomena would be suitable for the initiation of learning activities. Take, for instance, the following brief text:

> Playing tennis
>
> You've been playing a game of tennis among friends. It is a warm and sunny day. Unfortunately, you've lost the exciting game. When you walk home, you notice that you are wet all over your body, your face feels hot and looks scarlet and your leg muscles begin to ache.
>
> Please explain.

Clearly, what is to be explained here is why one becomes wet, feels hot and looks scarlet, and why one's muscles begin to ache, under the conditions described in the text (game of tennis; warm and sunny day; loss of game). Given this problem, students of medicine or students of biology would end up studying subject-matter related to the physiology of effort including thermoregulation.

Essential to the method is that students' prior knowledge of the problem is, in itself, insufficient to understand it in depth. During initial analysis, students will try to built a preliminary mental model of the processes responsible for the phenomena described, but, since their prior knowledge is limited, questions

will come up and dilemmas will arise that can be used as learning issues for subsequent, individual, self-directed learning. These individual learning activities based on the analysis of a particular problem will tend to take a couple of days (but may take longer). Subsequently, students would meet again and exchange findings, examining whether they now have acquired a deeper, more accurate, more detailed, understanding of what is going on underneath the problem's observable phenomena (Schmidt 1993).

While working on a problem, the group is guided by a tutor, usually a member of the faculty. His or her task is to stimulate the discussion, to provide students with some subject-matter information if necessary, to evaluate progress being made and to monitor the extent to which each group member contributes to the group's tasks (Barrows 1987).

Problem-based learning was originally developed in the context of health professions' education to deal with the perceived lack of relevance of much of what students in those fields were expected to digest intellectually. Problem-based learning was seen as a way out: Students were supposed to discuss professionally interesting problems and gather information relevant to the understanding and – possibly – solution of these problems. This would encourage knowledge acquisition driven by the needs of the students rather than by the preoccupations of the teachers. In addition, it would ensure professional relevance for as long as the problems presented would be professionally pertinent (Barrows & Tamblyn 1980). In its emphasis on everyday relevance and on the importance of active, self-directed learning, problem-based learning echoes the concerns of generations of educators going as far back as John Dewey (1910) and perhaps even earlier. Its actual appearance has features in common with Jerome Bruner's (1959, 1961) learning by discovery (although it does rely less on the idea that students should 'discover' principles themselves independently of teachers and books). But problem-based learning also fits in with recent developments in cognitive psychology. In particular the idea that learning is essentially an act of active construction on the part of the learner is well implemented in problem-based learning (Resnick 1989). Students are encouraged to actively construct a mental model of the phenomena, situations or events described in the problem and do this by elaborating on prior knowledge through small-group discussion (Schmidt, De Volder, de Grave, Moust & Patel 1989). In addition, subject-matter is studied with the purpose of constructing this model explaining the phenomena. Third, because the problem refers to a concrete situation or event in the real world, knowledge gained through problem-based learning can be considered contextual or situated and, therefore, more easily retrieved as the need arises (Brown, Collins & Duguid 1989).

The collection of papers published in this issue constitutes a representative sample of research conducted in this area. The first two articles deal with the problem-based learning process itself. *Dolmans* and her colleagues describe an attempt to chart the course of learning through collecting learning goals produced by small-group tutorials and comparing these goals with learning outcomes. They find that these outcomes do not seem to be entirely defined by what students say they will be doing but by other influences as well. *Geerligs* studied to what extent students' thoughts during small-group discussion are task-relevant. Research on student thinking during lectures has demonstrated that students often think about topics different from the subject-matter presented by the teacher. Using an alarm tone that played at random intervals, Geerligs required students to write down what was on their mind several times per session and during 10 consecutive sessions. The thoughts of students while engaged in problem-based discussion turn out to be overwhelmingly content-related, suggesting that problem-based learning indeed fosters the commitment of students to their learning.

The role of the tutor in problem-based learning has recently lead to heated debate between those who maintain that the tutor should be a subject-matter expert in the first place and those who believe that he or she should be a facilitator of the ongoing learning (Davis, Nairn, Paine, Anderson & Oh 1992; Schmidt, van der Arend, Moust, Kokx & Boon 1993; Silver & Wilkerson 1991). Three articles published in this issue contribute to the debate. *Schmidt* and colleagues present results of an educational experiment in which the performance of peer tutors was compared with that of staff tutors. They report that students tutored by staff tutors generally perform better on an end-of-course examination than those tutored by peers, although differences are small. *Moust and Schmidt* demonstrate that student tutors behave differently from staff tutors in several ways: Student tutors display a better understanding of the nature of difficulties that students face while attempting to master particular subject-matter. In addition, they show more personal interest in their students. By contrast, staff tutors made more extensive use of their subject-matter expertise while tutoring their group. *Wilkerson* surveyed students and faculty with regard to desirable skills for small-group tutoring. She reports that students and faculty alike value a tutoring style that allows students to take control over the process of tutorial discussion. In addition, both groups feel that a tutor must act as a role model in encouraging critical thinking and reflection. Students particularly emphasise the importance of subject-matter expertise in their tutors.

Assessment represents a special difficulty in problem-based curricula because students are given freedom to pursue learning goals that may or may not match the expectations of the teachers who designed the problems. *Van*

Berkel and his colleagues discuss theory and empirical results of an assessment procedure called 'progress testing.' Progress tests are administered to all students in a particular curriculum and, hence, attempt to measure knowledge growth in a domain over extended periods of time rather than knowledge acquired in the days before an examination. They report that growth can indeed be demonstrated over the course of the years and that achievement on progress tests is positively related to an orientation toward meaningful learning and negatively to a memorisation-oriented learning style.

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