

Essays on Teaching Excellence

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Problem-based Learning: Preparing Students to Succeed in the 21st Century

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Introduction Leaders in government, the private sector, and education agree that our entire educational system is in need of reform. A driving force behind this reform is the realization that successful employment and citizenship require different knowledge and skills than in the past (Wingspread Conference, 1994; National Research Council, 1996). Thus in addition to their more traditional role as purveyors of discipline-specific knowledge, teachers are being urged to adopt classroom methods that help students to develop the competencies identified as necessary for success, including the abilities:

- to think critically and analyze and solve complex, real world problems;
- to find, evaluate, and use appropriate learning resources;
- to work cooperatively in teams and small groups;
- to demonstrate effective verbal and written communication skills;
- and to use content knowledge and intellectual skills to become continual learners.

Problem-based learning (PBL) provides an environment for promoting these skills.

Problem-Based Learning The basic principle supporting the concept of PBL is older than formal education itself, namely that learning is initiated by a posed problem, query, or puzzle that the learner wants to solve (Boud & Feletti, 1991). In the problem-based approach, complex, real problems motivate students to identify and research concepts and principles they need to know in order to progress through the problems. Students work in small learning teams, acquiring, communicating, and integrating information in a process that resembles that of inquiry. PBL has its roots in the medical school setting where small groups of mature, motivated students work in small groups in a clinical context. In order to incorporate PBL in undergraduate courses, we must find models of instruction that allow one faculty member to teach large numbers of typical undergraduate students. Some faculty at the University of Delaware have been doing just that - piloting models for the successful incorporation of PBL into their undergraduate courses. Despite course-specific differences in the models, the following essential features (Engel, 1991) have been preserved:

- Students are presented with a problem (case, research paper, videotape, for example). In groups they organize their ideas and previous knowledge related to the problem and attempt to define its broad nature.
- As they discuss, students pose questions, called "learning issues," on aspects of the problem that they do not understand. They are continually encouraged to define what they know - and more importantly, what they do not know.
- Students rank, in order of importance, the learning issues generated, deciding which questions will be followed up by the group and which can be assigned to individuals, who later teach the rest of the group. Students and instructor also discuss the resources needed to research these issues and where they can be found.
- When students reconvene, they explore the learning issues and

integrate their new knowledge into the context of the problem. They are also encouraged to summarize their knowledge and connect new concepts to old ones. They continue this cycle of defining, researching, teaching, summarizing, and integrating learning issues as they progress through the problem.

Students soon see that learning is an ongoing process and that there will always be (even for the teacher) new learning issues to be explored. Because they learn concepts in context, they are more likely to retain that knowledge and apply it appropriately (Albanese & Mitchell, 1993) in novel situations. As they work through real problems, students will be confronted with the realization that knowledge transcends artificial boundaries.

Faculty Role What is the faculty role in PBL? The instructor guides, probes for deeper understanding, and supports students' initiatives, but does not lecture in advance on essential problem-related concepts, nor direct or provide easy solutions. The degree to which a PBL course is student-directed versus teacher-directed is a decision that faculty must make based on class size, intellectual maturity of the students, and course goals. For example, in a large class of novice learners, the instructor can interrupt the group problem-solving process at 10-15 minute intervals for whole class discussions or mini-lectures that assist students past conceptual barriers or allow them to "compare notes" on approaches to the problem. Adding this structure requires constant negotiation of the balance between necessary support and constraint of the students' intellectual initiatives. If the balance is tipped too far in the instructor-centered direction, students may no longer feel motivated or empowered to take a responsible role in their learning. As with any form of collaborative learning, faculty must be ready to yield some of their control over the learning enterprise to the students (Finkel & Monk, 1983).

Group-Based Learning There is a wide range of student experiences with groups. Because the success of PBL depends heavily on group work, the instructor must lay the groundwork for effective group functioning early. One strategy for the first week of class, is to initiate a discussion in which students describe their experiences working in groups, both good and bad. They then

suggest behaviors to promote beneficial aspects and discourage unproductive ones. It is important to form groups (and set them to work on problem-solving activities) usually no later than the second week of a course. In most instances, the groups should be permanent and given an intentionally or randomly heterogeneous composition by the instructor. After groups are formed, they establish a set of ground rules to which all members agree to in writing. These should include coming on time, being prepared for every class, respecting the views of fellow group members, and, importantly, dealing with members who do not follow the ground rules.

Managing Multiple Groups How can the instructor facilitate the problem-solving process when there is more than one classroom group? Models piloted at the University of Delaware include a combination of one or more of the following strategies.

- The faculty member serves as a "roving" facilitator, spending no more than 5-10 minutes with each group.
- Roles of responsibility rotate within each student group. Examples of such roles are "reporter", "recorder", "discussion leader", and "accuracy coach".
- Short, structured problems and associated assignments are used -- ones that provide a natural break point for groups to report to the class as a whole on important learning issues or to receive instructor guidance.
- Upper class undergraduates who have had prior PBL experience, particularly in the course serve as roving facilitators.

Problems & Instructional Materials The selection of appropriate problems is crucial for success. The following is a list of the important characteristics of a good PBL problem.

- The problem must first engage students' interest and motivate them to probe for deeper understanding of the concepts. It should relate the subject to the real world so that students will have a stake in solving the problem.

- Good problems require students to make decisions based on facts, information, logic, and/or rationalization. Problems should require students to define what assumptions are needed (and why), what information is relevant, and/or what steps or procedures are required to solve the problem.
- The ideal problem is constructed so that not all of the information needed for a solution is initially provided. For this reason, many PBL problems are designed with multiple pages, to be given to student groups one at a time as they work through the problem.
- Cooperation from all group members is necessary in order to work through a good problem effectively. The length and complexity of the problem or case must be controlled so students realize that a "divide and conquer" effort will not be a successful strategy. For example, a problem that consists of a series of straightforward "end of chapter" questions may be divided by the group and assigned to individuals, then reassembled for the assignment submission. In this case, students end up learning less not more.
- The initial questions on the first page of a problem should be open-ended, based on previously learned knowledge, and/or controversial so that all students are initially drawn into discussion. This strategy keeps the students functioning as a group, rather than encouraging them to work individually from the outset.
- The content objectives of the course should be incorporated into the problems, connecting previous knowledge to new concepts and connecting new knowledge to concepts in other courses and/or disciplines. Problems can also be constructed so that they help students build upon skills or process objectives in incremental fashion.

Summary Problem-based instruction can help develop the skills necessary for success in college as well as the world outside the classroom. As students in problem-based classes become participants in a community of continual learners, the faculty who

teach them witness the excitement of discovering their discipline through their students' eyes.

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