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The Process of Problem-Based Learning: A Literature Review

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THE PROCESS OF PROBLEM-BASED LEARNING:

A LITERATURE REVIEW

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Abstract: Problem-based learning is a promising new instructional strategy currently being implemented in all levels of education from institutions of higher learning to kindergartens. To encourage continued implementation, this literature review examines the process of problem-based learning, elucidating for the educator issues surrounding each of the primary steps in such implementation. A brief history of problem-based learning is given, followed by a working definition of this strategy. Then, the article summarizes information in the current literature

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surrounding each of the following steps in problem-based learning: problem presentation, separation of known facts from unknown issues, individual research, group analysis, solution generation, solution presentation, and evaluation.

Introduction

Problem-based learning is a promising new instructional strategy developed for use in medical school curricula that is currently being implemented in all levels of education from institutions of higher learning to kindergartens. This strategy is particularly suited for utilization in health occupations education, as it gives students the opportunity to confront authentic problems of health care practice in an educative setting. Therefore, within the problem-based learning classroom, students can develop problem solving skills and clinical insights which will aid them in their own future endeavors within the health care field. To encourage the implementation of the problem-based learning strategy within health occupations programs, this literature review examines the process of problem-based learning, elucidating for the educator the issues surrounding each of the primary steps in such implementation. A brief history of problem-based learning is given, followed by a working definition of this strategy. Then, the article summarizes information in the current literature surrounding each of the steps in the problem-based learning process.

History of Problem-Based Learning

Problem-based learning began in the education of medical students. Howard S. Barrows, a physician and neuropsychologist, is most frequently attributed with its invention and implementation (Knoll, 1992). Barrows worked with medical students in a neurological clinical clerkship in 1964, and noted that these students experienced difficulty in applying their basic science knowledge in order to make diagnoses based upon patient symptoms. Barrows, making reference to this situation, stated that medical schools of the time emphasized the delivery of content and thereby relegated the evaluation and management of the patient's medical problem to "vocational skills" (Barrows & Tamblyn, 1980, p. 5). In his writings, Barrows reminded medical school faculty, "A student's acquisition of a large body of knowledge in medicine and the basic sciences is no assurance that he knows when or how to apply this knowledge in the care of patients" (Barrows & Tamblyn, 1980, p. 6).

Barrows determined to redesign the curriculum of medical school with the objective of addressing the perceived problem. In order to teach students how to apply basic knowledge in clinical settings, Barrows investigated the clinical reasoning of practicing physicians (Knoll, 1992). He began by videotaping physicians interacting with patients. Immediately subsequent to this interaction, the physician was interviewed by Barrows and asked about the thinking processes used throughout the patient encounter. "The reliving of an encounter with the patient, while the experience is still fresh, allows the subject to become aware of his thought processes," according to Barrows (Barrows & Tamblyn, 1980, p. 22). From such studies, Barrows observed that seasoned diagnosticians immediately generated a number of diagnoses based on very little hard information, and then used the remainder of the patient interview to substantiate, eliminate, or generate alternative diagnoses. The thought processes of these diagnosticians were "circular, over-lapping webs of information" which contrasted sharply with the linear, sequential delivery of information in the medical school classroom (Knoll, 1992, p. 322). Therefore, Barrows determined that this type of reasoning, this cognitive process, was the integral skill that medical school curriculum failed to convey. This, then, became his objective: to find a way to incorporate the teaching of clinical reasoning skills into the curricula. This objective led to the development of problem-based learning.

Since Barrows' first implementation of problem-based learning, this instructional strategy has been adopted by disciplines other than medicine. Problem-based learning, or PBL, can now frequently be found in engineering schools, educational leadership programs, business school curricula and has even been adapted for use in elementary, middle school, and secondary school classrooms. In this literature review, problem-based learning is defined and the steps in the process of PBL used in these settings are enumerated and explained.

Definition of Problem-Based Learning

"Problem-based learning" has a familiar ring to many science educators. Problem solving techniques, as the "scientific method," have been part of science instruction for "at least three quarters of a century" (Helgeson, 1992, p. 1). Other terms used to describe problem solving include: scientific thinking, critical thinking, inquiry skills, and science processes. So, is problem-based learning just a re-emergence of a well-documented, tried and true instructional technique, a new name for an already existing process? No, problem-based learning is more than this. Problem-based learning (PBL) is a teaching strategy that reflects a new way of thinking about teaching and learning.

Bridges and Hallinger (199 1) defined problem-based learning as learning which begins with a problem. The problem should be one that students are apt to face in the future, or at least similar in context to ones students will encounter in their planned careers. The subject matter in the course or class should be organized around the problem, rather than into separate disciplines. In working through the problem, learning occurs mostly within the context of the problem in small groups, rather than in large, lecture-oriented assemblies. Within the small groups, individuals assumed the major responsibility for their own learning and indeed, for their own instruction. One model used to elucidate PBL is that of writing a dissertation (Butler, 1997). In such an activity, the learning certainly begins with a problem. The student is likely to face such a problem again, as the whole purpose of a dissertation is to allow the student to gain experience within a chosen field. What the student learns from the dissertation study is centered around the research question. While this research question may be located within a particular discipline, skills from other disciplines will be utilized in the study, as mathematics and language arts. The student is expected to be autonomous in this activity, therefore the major responsibility for learning and instruction does fall to the student. The learning occurs primarily within a small group consisting of the student and a directing faculty committee.

Steps In the Process of PBL

This definition of PBL, then, provides a background for the appropriate implementation procedures for problem-based learning. The process of PBL is further explained in this section, using information from the current problem-based learning literature. In brief, the steps in the PBL process begin with a problem. This problem becomes more defined as students separate known facts about the problem topic from unknown issues. A problem statement or research question is written. Data collection begins and group analysis of these data are now incorporated into the process. After several cycles of data collection and analysis, possible solutions to the problem are formulated. The potential solutions are examined in the light of all the evidence collected and the most viable solution is then selected. The PBL experience culminates with the public sharing of the solution and some type of evaluation. This evaluation may be formal or informal; self-, peer-, or instructor-assessed, written or oral.

The Problem

Like the graduate student beginning a dissertation study, the student in a PBL classroom begins with a problem. This is one way in which the traditional classroom differs from the PBL classroom. In the traditional classroom, instruction usually comes before problem presentation (Gallagher, Stepien, Sher, & Workman, 1995). In this classroom, the usual order of operation is theory, then practice. The problems, when presented, may be in the form of exercises (as math problems which reinforce a particular concept) or in the form of experiments (which illustrate a scientific principle) (Boud, 1985). There is usually a “right” answer for such problems, so students are evaluated on the accuracy of their responses. That is, they are evaluated on how well their responses match an expert’s answer (Dunkhase & Penick, 1990).

Alternatively, PBL students are presented with a problem before any instruction is given. Dods (1996, p. 225) calls the problems “engagers” because “they engage the student as an active participant in the learning process.” In fact, the problem serves as a focal point for knowledge acquisition and application and drives the instruction (Dolmans, Gijselaers, & Schmidt, 1991). Woods (1994) agreed, stating that it is through wrestling with a solution to this problem that knowledge is acquired. The PBL problems are not simple exercises to illuminate one particular concept. Since the problems have more than one correct solution, students are not judged on how well their answers match an expert’s, but on the viability of the solution (Gallagher et al. 1995).

The above comments serve to introduce this topic of PBL problems. Further information about PBL problems within the current literature covers such topics as characteristics of problems, problem selection, and problem presentation.

Characteristics of Problems

Dunkhase and Penick (1990) mentioned two characteristics in their description of PBL problems. They felt that problems presented to students in the PBL classroom should be complex and should attempt to exemplify real world scenarios. Complexity of problems is further explainedbyHuhtala(1994) who stated that PBL problems should be chosen from topics that are concrete enough for students to investigate thoroughly, but narrow enough for students to grasp important details. They should also be of sufficient complexity to lack obvious solutions. To this end, writers must be cautious to avoid including too many "critical" factors, factors which give too much information about the problem, warned Savery and Duffy (1995). Another cautionary note is sounded by Feden (1994). He stated that complex problems may change course in the middle of an investigation and become even more complex as pupils tackle them.

Middleton (1994, p. 151) used the term "ill-defined" to describe such complex problems. PBL problems are ill-defined when they contain vague or ambiguous problem statements with missing details, have no known solution path, are new or have never been solved before, according *to this* author. Gallagher et al. (1995, p. 138) used the term "ill-structured" rather than ill-defined to describe the complex problems of problem-based learning. Like Dunkhase and Penick (1990), Huhtala (1994), and Middleton (1994) Gallagher et al. (1995) described the initial situation of ill-structured problems as lacking sufficient information to develop a solution, or perhaps to even precisely define the nature of the problem. Cordeiro and Campbell (1996, p. 8) concurred with this view and divide PBL problems into "high ground" and "swampy" problems. High ground problems are of a technical nature, where a well-rehearsed procedure for solving is available. The authors discard the idea of using such problems in problem-based learning, urging the use of swampy problems instead. Swampy problems, they stated, are more complex and occur "when one only vaguely understands the situation, has no clear way of knowing what would be better, and lacks procedures for addressing obstacles or constraints of the sitnation." Gallagher, Stepien, and Rosenthal (1992) further described such problems as having no one single best way to be tackled and no single right answer. In fact, they stated that students may never be one hundred percent sure of making the correct solution selection, since some information is always missing.

Such ill-structured problems best resemble the nature of problems as they occur in the real world. A further advantage of such reality-based problems is that they tend to be more interesting, hence more motivating to students (VanTassel-Baska, Bailey, Gallagher, & Fettig, 1992). These reality-based problems give just sufficient information to students to arouse their interest and then motivate them to obtain more information (Snellen-Balendong, 1992).

The "real world" nature of problems is also important to Cordeiro and Campbell (1995, p. 5). They differentiate between "authentic" and "simulated" problems, but felt that both fulfill the purpose of problem-based learning by initiating perturbation. Authentic problems, according to these authors, are ones which are ripped from today's headlines; ones which are actual problems of current practice within a profession. Simulated problems, on the other hand, are ones which are created by instructors or ones which have occurred within the profession in the past. With both types, however, students can feel that they are focusing on real problems which, in fact, need solutions.

Boud (1985) pointed out that these real problems are also inherently interdisciplinary, as real world problems do not usually limit themselves to one particular discipline. So, another characteristic of PBL problems is that they will guide the students to explore more than one academic area.

From the above discussion, it is clear that the PBL literature recommends problems which are complex *in nature,* authentic in presentation, and interdisciplinary in approach.

Problem Selection

Under problem selection, three questions emerge: Who will write the problems? What are some sources of PBL problems? and What is the purpose of the problem?

Tanner, Keedy, and Galis (1995) believed that problems can be selected by the curriculum designers or by students. Barrows and Tamblyn (1980, p. 51) particularly recommended student-generated problems, stating, "very effective student learning is derived from asking students to produce problem-based learning units for other students . ..It takes considerable study and scholarship to put together a problem in a simulation format and to provide evaluative tools." Dolmans, Gijselaers, and Schmidt (1992b) believed that teachers should develop the problems used in their courses. Grisson andKoschmann(1995) saw problem development by teachers not so much as a virtue, but rather as a necessity. They bewailed the lack of published problems and stated that teachers will be forced to write their own. Writing problems may call for specialized skills that the teacher does not possess. Therefore, Grissom and Koschmann (1995, p. 294) recommended a development team approach. They described such a problem development team for a hypermedia teaching case as including "graphic artists, programmers, domain specialists and human factors engineers."

No matter who writes the problems, ideas for these problems must be generated. The best problems are those that arise from the personal or professional experience of the author, stated Boud and Feletti (1991). One characteristic of best problems is that these problems usually develop from real situations or are written to reflect a real situation, which gives added relevance to the case in the eyes of the students. Relevance is also of importance to Savery and Duffy (1995, p. 36). They stated that "students must own the problem, which means they must perceive it as real and one which has personal relevance." Sources for such real life problems include magazine and newspaper articles, graphs, visual media, or documents (Tanner et al. 1995). Many times, such artifacts portray a discrepant event (Myers, Purcell, Little, & Jaber, 1993) in order to stimulate student interest (Son & VanSickle, 1993). Huhtala (1994) recommended using problems that involve local issues, as these tend to be emotionally charged, possess the added advantage of ready access to primary source material, and again, are reality-based, and therefore highly relevant to students. Bridges andHallinger(1991) explained that the problem should be one that affects large numbers of people, as this type of problem has the greatest impact. They also felt that it is important that problems be authentic, ones that the student will likely face in the future. Pajak, Tanner, Rees, and Holmes (1995, p. 3) labeled such reality-based problems as "problems of professional practice."

Writing such problems can be a painstaking activity, since one goal of the problems could be to direct students into specific content areas (Dolmans, Gijselaers, & Schmidt, 1992a). When students analyze the problems and attempt to formulate solutions, they' find that their prior knowledge on the subject is insufficient to the task. Therefore, the questions that remain unanswered serve as guides for independent and self-directed learning, driving students to a deeper understanding of the concepts embedded in the problem (Dolmans et al. 1992a). Ineffective problems will lead students to select learning goals other than those designed to be selected by the teachers (Dolmans, Gijselaers, & Schmidt, 1991). Other problem goals include helping students learn ideas or techniques, encouraging students to pursue a particular field of study (career orientation), and representing *a* typical problem faced by a profession. Problems may also be presented because they are intrinsically interesting or particularly important (Tamer et al. 1995). They maybe used *to* simulate creative thinking processes in order to achieve resolution (Middleton, 1994). Finally, problems can be a means by which to enculturate students into the work place environment (Cordeiro & Campbell, 1995).

Problem selection, then, is an important part of the PBL process. Such selections can be made by students, teachers, curriculum designers, or development teams. The best sources for problems come from real life, or problems of professional practice. Goals for problems may differ. Some problems lead students to explore certain curriculum areas, some provide authentic experiences within a particular career field, and some may just be interesting (and therefore highly motivating) to pursue.

Problem Presentation

Once a problem is selected, it must be presented to students. Lengths of problem presentations run from the "half page of print" recommended by Snellen-Balendong (1992, p. 262) to "20-page cases" (Boud & Feletti, 1991, p. 151). Formats for presentations also differ. The initial presentation may be in the form of an event or "trigger" (Tanner et al. 1995, p. 155). Such an event can be "discrepant," meaning that it is an inexplicable condition, statement or situation (Myers et al. 1993, p. 159). Barrows and Tamblyn (1980, p. 164) described "card deck" formats, where the cards contain information about a medical patient. They recommended this format for its portability, ease of use, and adaptability. This format seems, however, to be simply the forerunner of hypermedia formats. Several articles recommended the hypermedia format for ease of navigation from subject *to* subject via "buttons" (Grissom & Koschmarm, 1995) and for the ability to select individual data items within a section, which requires students to generate questions before information is displayed (Nelson, 1993). Another distinct advantage of this system is the ability to manage and organize large amounts of information (Kumar, Smith, Helgenson, & White, 1994). Of course, the card deck system still has one advantage over these later developments. As Barrows and Tamblyn (1980, p. 138) pointed out, it “does not require complex audiovisual hardware!”

In addition to written problems or computer-based problem presentations, other problem formats mentioned in the literature include: vignettes with limited amounts of information, filmed episodes, real-time problematic situations (Walker, 1995), elaborate simulations of companies and industries, real life situations presented by cooperating companies, or current situations reported in the press (Stinson, 1990).

No matter what format is used, Ma (1994) stated that the reality of the situation will be enhanced if the problem is presented to students in the same manner in which they would encounter such a problem in the real world. So, formats can be long or short, written or filmed, computer-simulated or real-life.

Separation of Known Facts from Unknown Issues

Returning to the dissertation model at this point, it is evident that only the first step in PBL has taken place. A vague problem is now forming in the grad student’s mind. This problem might have arisen from some experience of the student or it could have been suggested by a major professor. Regardless of its source, the time has come to examine the problem more deeply. Each student must ascertain what is already known about the problem and what unknown issues may need to be researched.

In PBL, as with the graduate student, the presentation is "cold," said Savery and Duffy (1995, p. 34). This means that students do not know what the problem will be until they are confronted with the presentation materials. So, the next step is to begin to make sense of the circumstances related in the problem. Savoie and Hughes (1994) suggested that students utilize three questions to separate facts from judgments, to speculate about causes and effects, and to evaluate possible actions. These three questions are: "What do we know? What do we need to know? and What are we going to do?' (Savoie & Hughes, 1994, p. 55). These questions will also foster discussion within small groups of students, as the students begin to generate hypotheses based on prior knowledge or experience (Savery & Duffy, 1995). Once facts are listed and prior knowledge is shared, students begin to identify "learning objectives" (Bridges & Hallinger, 1991), which are unresolved issues, questions arising from issues (West, 1992), or knowledge deficiencies of the group (Ryan& Koschmann, 1994). In this manner, students assess their own state of knowledge relative to the problem and formulate learning needs (Hmelo, Gotterer, & Bransford, 1994). These learning needs will drive the next stage of the PBL process.

Individual Research

The graduate student in our model of PBL must now consult experts in order to investigate the problem further and begin to illuminate the dark, unknown crevices of the problem. Now is the time for research, which the graduate student peruses in a solitary fashion. This phase, for the graduate student, ends with the writing of the research question. Then, more precise reading is done to inform the research plan. The graduate student takes this plan to a group, the faculty committee. The plan (after possible revision from the committee) is then implemented and data collection begins. This starts a new round of individual research.

A typical PBL student will follow a very similar process. However, the PBL student does not share membership with a faculty committee, but with a group of peers. Following the listing of learning objectives, the most common course of action is a division of labor within this group, as students choose a particular area in which to concentrate their research (Huhtala, 1994). Hadwin (1996, p. 5) described three "shapes" of problem-based learning with the "shape" depending on how the students divide up the learning objectives. The objectives can be divided among students, so that no two students have the same objective or every student can research every objective. Midway between these two approaches is a shape of PBL which contains elements of both. Here, students define central and peripheral issues. Every student researches central issues, while peripheral issues are divided among the group members.

Once division of labor is completed, it is time for the students to answer the question "What are we going to do?' (Savoie & Hughes, 1994, p. 55). The answer is usually for students to perform research, which is an independent study, inquiry-based, self-directed activity (Stinson, 1990; Woods, 1985). This research might be in the form of experiments, observations, or even calculations (Gallagher et al. 1995). Students may talk to experts or interview other resource persons (Savoie & Hughes, 1995). They may consult books, articles, films (Walker, 1995), newspapers, or news shows (Huhtala, 1994). Technology also offers support to PBL in information collection, as electronic information technology provides various options for rapid collection of information needed to solve the problem (Ryan & Koschmann, 1994).

Group Analysis

The purpose of all this information gathering and research is, of course, to shed light on some aspect of the problem. While the research is performed by individuals working alone, the results of the research must be communicated to the group or team (Van Dieijen, 1990). This is true for the PBL student, just as it was the dissertation-writing graduate student. The grad student usually has two formal rounds of group analysis, one at the prospectus defense and one at the dissertation defense. However, informal interaction with the faculty committee continues throughout the project.

In a PBL group, the informal interactions between group members predominate. Students discuss the learning objectives and the data collected concerning these objectives. In this manner, expertise on each aspect of the problem is distributed and shared among all the group members (Hadwin, 1996). The group decides whether the research results do contribute to the understanding of the problem, or do not. If they don't, the original learning issues may be refined or rewritten. Then, students return to the research phase to gather more information on the altered issues (Gallagher et al. 1995). This two-step phase of independent study and collaboration is continued until every member of the group is satisfied that the problem has been sufficiently explored (Ryan & Koschmann, 1994). The number of iterations needed depends on the complexity of the problem and/or the learning issues (Stinson, 1990).

To Lyons (1990, p. 7), this process of iteration-reiteration is of paramount importance and reflected in the name he gave to this learning procedure—"reiterative problem-based learning." This hermeneutic process is also praised by Ma (1994), who saw this process as a chance for students to apply knowledge and skills recently acquired back to the problem. In this manner, learning is reinforced and the effectiveness of the learning is evaluated. Knowledge gained in this manner is contextualized, according to Bridges and Hallinger (1991). Students learn a variety of subject matter since the knowledge is organized around problems, rather than disciplines (Tanner et al. 1995). The sharing of information among group members is the portion of the process which strikes Hadwin (1996) as the primary advantage of this system. She spoke of building a "community of learners" (1996, p. 5). As a constructivist, she believed that knowledge is socially constructed, so this activity is conducive to learning. She also saw the collaboration among students as authentic to real world situations, where practitioners update their knowledge and skills by consulting colleagues. So, not only are students acquiring knowledge, but they are experiencing a culture and a context in which to practice these newly acquired skills.

Solution Generation

Once knowledge is accumulated through research activities and then shared among group members, the group must move to the last phases of problem-based learning. These are the phases in which a solution is generated, a presentation is made to an audience, and an evaluation is performed. These activities hold true for both the graduate student model and for actual PBL students.

Gallagher et al. (1992) required students to generate several different problem solutions and then to analyze them for efficacy. This analysis forces students to articulate acquired knowledge (Myers et al. 1993) and to make generalizations based on this new knowledge. These generalizations are on the order of similarities and differences between the problem under discussion and the information found in the research materials (Ryan & Koschmann, 1994).

Solution Presentation

After analyzing possible solutions and choosing the most viable, students present the solution to an audience (Gallagher et al. 1995). The form of the presentation maybe a written report (like the graduate student's dissertation document), an oral presentation (Hoover & Achilles, 1996), a group paper, a steering committee report (Huhtala, 1994) or a dramatization (Son & VanSickle, 1993). In the presentation, the solution is made public and the reasoning behind the solution is made apparent in order *to* support the selection of this particular solution (Woods, 1985).

Evaluation

The final stage of problem-based learning for both graduate students and students in PBL classrooms involves evaluation. Discussions of problem-based learning evaluation within the current literature suggest that there are two major areas of interest in this field. These interest areas are the evaluation of participants and the evaluation of the problem-based learning experience itself.

In participant assessment, the evaluation can be performed by the student, by a peer, or by the teacher. Woods (1985) recommended that student self-performance evaluations are of utmost importance. However, he stated that formal evaluation instruments for such assessments are not always necessary. Barrows and Tamblyn (1980, p. 110) agreed, stating, "Self-directed study requires the student to review his own work with the problem, to generate the questions and *issues* raised during this work. This is an evaluation." So, just in the process of working through a problem, students have to perform many self-evaluations. Ryan and Koschmann (1994) called such in-process evaluations reflection activities.

Tanner et al. (1995) also saw the value of student self-assessment, but feel that students may also evaluate each other or experience evaluation by the instructor. West

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(1992) recommended that an assessment of performance be done not only on every student, but on each group, and on the teacher. Student evaluation areas listed by Savery and Duffy (1995) included self-directed learning, problem solving skills, and skills as a group member as their three most important domains to evaluate. Like Savery and Duffy, Boshuizen et al. (1995) believed that student problem solving should be assessed.

Assessing student content knowledge is another important focus of student evaluation to some authors. Dolmans et al. (1992a) reported on using an achievement test at the end of a PBL unit. They warn, however, that such a test is only valid if it reflects the topics addressed *in the* problems presented during the PBL experience. Blumberg and Zeitz (1990) also focused on the use of exams and they report that some medical schools use faculty-generated learning objectives to determine content on such exams, while other schools use student-generated learning issues for exam topics. In contrast to standardized tests, students in Huhtala's study (1994) constructed their own culminating exam. Student groups each wrote two essay-type test questions on the topics they researched and then were responsible for grading these test questions.

As the above discussion demonstrates, assessment of students' reasoning skills and content knowledge are important foci of evaluation in the PBL field. Another type of student assessment centers on solution viability. An evaluation of students' solution viability was done by a panel of experts in Stinson's classes (1990). Wheatley (1990, p. 539) also sanctioned this solution-viability type of evaluation, but believes that such viability assessment should be done by student groups. Assessment of student participants, whether in the areas of reasoning skills, content knowledge, or solution viability is not enough for Des Marchais, Schmidt, and Black (1989). They emphasized a farther need, that of evaluating program effectiveness. Such a program evaluation, they felt, is an important instrument for quality control. Brandon, Lindberg, Anderson, and Gerhard (1992) concurred with this assertion and make specific recommendations for such an evaluation. They particularly stressed the inclusion of stakeholders (those who are affected by the curriculum and who have considerable first hand knowledge about it) in any program evaluation. Once data are collected from stakeholders, it can be used to examine the congruence between the goals of the curriculum and the goals of the participants, to identify any problems in implementation of the curriculum, to ascertain components of the curriculum that require elaboration, and to plan future educational activities.

One way in which data can be collected from stakeholders is described by Blumberg and Zeitz (1990). They reported that many medical schools compare the learning issues generated by the students to the learning objectives listed by the faculty designers of the problems in PBL. Their findings show that "generally 80-90% of the faculty objectives [are] covered in the student learning issues" (Blumberg & Zeitz, 1990, p. 12). The supposition here is that if students generated the same issues as the designers, the problem must bean effective one. Eagle et al. (1992) lauded the efficiency of this system, especially when comparing it to other methods of data collection such as direct observation of students and videotape analysis of group interaction. However, they warned that this method of comparing student learning issues to faculty objectives has its limitations. The record will not show the time spent by the group on a particular issue nor will it show learning issues which were resolved by the group.

A related study involving faculty objectives is described by Dolmans et al. (1991), with a few variations from the techniques previously discussed. In this study, student learning issues were not used. Instead, the faculty objectives were listed on an instrument named the Topic Evaluation Questionnaire. Students were asked to indicate the amount of time spent on each listed topic, using a Likert scale, with "1" being "no time" and "5" indicating "very much time" (Dolmans et al. 1991, p. 5). The authors felt that by examining the time students spend studying each topic related to a problem, the teachers can collect information about how the problem should be improved. In fact, they also felt that the Topic Evaluation Questionnaire measures whether students' actual learning activities (i.e. study time) encompass the intended course content.

Pajak et al. (1995) used a qualitative framework with multiple data sources to evaluate their program. Data were collected from direct observations of group interaction, interviews with students and faculty, participation in faculty debriefings, surveys, in-class evaluations, and student reflection papers. The analysis of these data was intended to identify issues by using the actual words of participants. Beebe's (1994) study also used multiple sources to evaluate the PBL experience of student teams. The students evaluated the teacher on a university-adopted form, a student survey on effectiveness of certain aspects of the course was used, and a survey given to the panel of experts who judged student performance was collated. Analysis of these data revealed the portions of the course that appeared to be most effective and least effective to participants. A similar, but less comprehensive evaluation method is also described by Walker (1995, p. 23).

The above studies all indicated the importance of participant input to the evaluation process. Whether student performance or program effectiveness is the central issue of the evaluation, assessment activities are an integral part of the problem-based learning experience. They are the culminating activity of PBL, following problem presentation, separation of known facts from unknown issues, individual student research, group analysis of research with possible reiteration of the research cycle, generation of alternative solutions and selection of best solution, and presentation of the selected solution to an audience.

Summary of Implementation Issues

The purpose of this literature review has been to provide, in summary form, an overview of the problem-based learning process in order to encourage its implementation by health occupations educators. Basically, PBL involves the development and practice of problem-solving strategies. Within this PBL framework, educators present ill-structured, complex problems to students. Students work in small groups to separate known facts from learning issues and then perform research activities to make the unknown, known. Groups analyze the results of such research, formulate solutions, and present solutions to a public. Evaluation in the PBL process may involve student assessment or process assessment.

While the steps of PBL appear to be very linear, it is clear from the literature that implementation of these procedures maybe cyclical, involving several iterations of certain steps. This graphic (see Figure 1) summarizes the steps of problem-based learning found within the current literature and emphasizes these multiple iterations.

The author challenges fellow health occupations educators to adopt problem-based learning, a promising new strategy which encourages the development of problem-solving skills in our students and which allows them to grapple with authentic problems of health care practice while still in an educative setting.

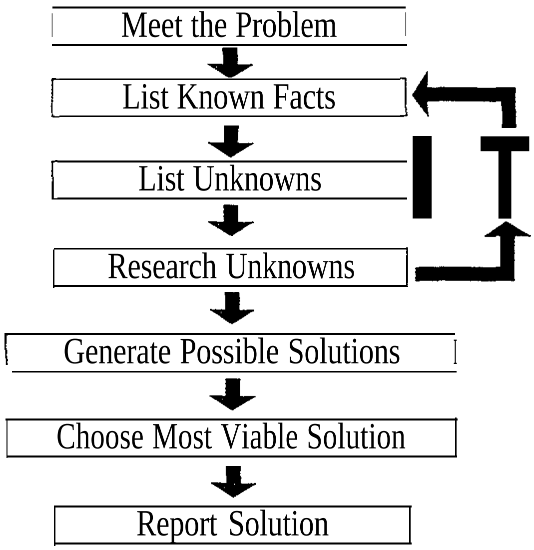

Figure 1: Steps in Problem-Based Learning

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