

# Cultivating Problem-Solving Skills Through Problem-Based Approaches to Professional Development

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*An extensive literature review was conducted of four problem-based approaches to professional development: (1) case study, (2) goal-based scenario, (3) problem-based learning, and (4) action learning. The review comparatively analyzed the training designs of these four approaches and found key differences in the nature of their case problems and training strategies. Specifically, the analysis found that case problems are ill structured in action learning and problem-based learning, are moderately structured in a goal-based scenario, and are fairly well structured in the case study approach. In addition, it was found that prototypical problems are used to a much greater extent in the problem-based learning and goal-based scenario approaches than they are in the other two approaches. Furthermore, the analysis found that the case study approach uses the most expert-oriented training strategy, the goal-based scenario approach uses a more learner-oriented strategy than the case study approach, and the problem-based learning and action learning approaches use strongly learner-oriented strategies. These design differences suggest that the case study and goal-based scenario approaches are more likely to result in single-loop learning and to foster the ability to solve well-structured problems, whereas the problem-based learning and action learning approaches are more likely to lead to double-loop learning and to promote the ability to solve ill-structured problems. Implications of these findings for the design and research of problem-based approaches to professional development are discussed.*

Problem solving is an important aspect of professional practice (Bereiter and Scardamalia, 1993). Professionals rely on their problem-solving skills to handle the increasingly ill-structured nature of their work (Schön, 1987).

Organizations sponsor a variety of formal professional development programs to develop the problem-solving skills of their professional staff. It is believed that because professional development programs generally focus on work problems as the basis for learning, the ability of professionals to solve problems improves as a result of their participation in these programs (Dixon, 1998; Lohman and Finkelstein, 2000; Schank, Berman, and Macpherson, 1999). However, previous research has found that problem-based approaches to professional development vary in their ability to promote higher-level cognitive skills (Albanese and Mitchell, 1993; Marsick, 1990a; Gallagher, 1997; Maudsley, 1999). Therefore, a detailed examination of the ways in which problem-based approaches to professional development are designed is warranted. Such an examination will provide useful information for designing professional development programs that promote the kinds of skills that professionals require in today's workplace.

### **Problem-Based Approaches to Developing Professional Expertise**

Traditional studies of expertise have established that experts differ from novices in the way they solve problems (Chi and Glaser, 1985; Chi, Glaser, and Farr, 1988; Larkin, McDermott, Simon, and Simon, 1980). Experts possess sophisticated schemata that contain information about the goals, facts, constraints, solution procedures, and possible solutions related to particular problems (Palumbo, 1990). Schemata are activated by experts during problem solving and enable quick movement from the identification of a problem to the selection and implementation of solution procedures. Activation of schemata reduces the amount of mental resources that a person requires to deal with a problem, thus increasing his or her mental capacity to attend to the important details of a problem—details that might prove critical to its accurate classification and resolution. Experts continually expand their expertise by reinvesting their mental resources to progressively reformulate fundamental problems at higher and higher levels of complexity (Bereiter and Scardamalia, 1993).

Professional development programs often focus on work problems as a vehicle for learning (Fulmer, 1992; Macpherson, Berman, and Joseph, 1996; Maudsley, 1999). A decision that is to be made when designing these programs concerns how to structure and present problems so as to promote and reinforce expert problem-solving behaviors (Albanese and Mitchell, 1993). The four problem-based approaches that are typically used in professional development programs are (1) case study, (2) goal-based scenario, (3) problem-based learning, and (4) action learning. The case study approach involves a trainer leading a group of trainees through the identification, analysis, and resolution of a problem (Fulmer, 1992; Harling and Akridge, 1998). In the goal-based scenario approach, trainees are required to perform procedural tasks in a simulated work environment to accomplish a goal (Schank, 1994).

The problem-based learning approach engages trainees in a cyclical process of problem framing, self-directed learning, and hypothesis formation and testing to solve an ill-structured problem (Hmelo and Ferrari, 1997). And in using the action learning approach, a group of individuals selects a real work problem to address, frames and analyzes the problem, generates and implements solutions, reflects on the results of the group's actions, and takes action again (Dixon, 1998).

Whereas all four approaches involve trainees in the problem-solving process, clear differences exist with respect to the structure of the problems addressed and their representation of typical problems that trainees face in practice (Gallagher, 1997; Marsick, 1990a; Norman and Schmidt, 1992; Schank, 1994). Furthermore, the four approaches differ with respect to the types of training strategies that are used to guide trainees through the problem-solving process (Barrows, 1996; Marsick, 1990a; Schank, Fano, Jona, and Bell, 1993a; Watkins and Brooks, 1994). These design differences are significant because they result in different types of learning outcomes, particularly as they relate to problem-solving skills—skills that professionals require to handle the increasingly ill-structured nature of their work.

Therefore, the purpose of this study has been to comparatively analyze the designs of the four aforementioned problem-based approaches to professional development and the impact of design differences on the development of problem-solving skill. Three research questions have guided the analysis: (1) How does the structure of the case problems differ in the selected problem-based approaches? (2) How does the design of the training strategies differ in the selected problem-based approaches? (3) If substantive differences in case problems and training strategies are found, what impact do the differences have on the development of problem-solving skills?

## Methods

A literature review of problem-based approaches to professional development was conducted. Education literature, as well as business and medical literature published in the past ten years, was reviewed. The PsychInfo, Medline, Florida State University Library, and ERIC data bases were searched. *Keywords* used in the search included: action learning, case-based, case method, case study, goal-based scenario, independent learning, learning skills, learning strategy, management training, problem-based, problem-based learning, problem solving, professional continuing education, professional development, and training strategy.

The initial search yielded 238 articles that dealt with one or more of the identified keywords. Ninety-four of the 238 articles clearly did not deal with problem-based approaches to professional development or problem-solving skill development and were therefore eliminated from the study. The abstracts for the remaining 144 articles were reviewed. Of the 144 articles, forty-eight

were found to focus on youngsters in undergraduate education and public school contexts rather than on adults in professional development contexts and so were also eliminated from the review. The resulting literature, consisting of ninety-six articles, was reviewed. References of relevant articles were collected as the review of the ninety-six articles progressed. Ten additional articles pertaining to problem-based approaches to professional development were found in this manner, making a total of 106 articles that were included in the review. These articles were published in a range of professional journals from fields such as business, health care, education, and agriculture. Of the 106 articles, thirty-six dealt with the case study approach, eighteen dealt with the goal-based scenario approach, twenty-nine dealt with the problem-based learning approach, and twenty-three dealt with the action learning approach.

The review process involved inducing themes relevant to the three research questions from the information found in the 106 articles. Based on recommendations for designing effective instruction, as presented by Gagne and Medsker (1996), Kemp, Morrison, and Ross (1998), and Smith and Ragan (1999), seven training design features were selected as the focus of this review: (1) training goals and objectives, (2) training content, (3) training strategies and events, (4) training participants, (5) delivery systems, (6) training evaluation methods, and (7) training outcomes. A matrix of professional contexts, publication sources, and the seven training design features was created for each of the four problem-based approaches. The four matrices were used to accumulate and organize relevant information obtained during an in-depth review of each of the 106 articles. Themes were induced from the completed matrices that captured key similarities and differences in the training designs of the four problem-based approaches.

## Findings

The review of literature found that all four problem-based approaches focus on multidisciplinary and complex work problems as the vehicle for learning (Adelskold, Aleklett, Axelsson, and Blomgren, 1999; Bridges and Hallinger, 1997). An example of such a problem is a management case concerning the airline People Express (Graham, Morecroft, Senge, and Serman, 1992). This extensive case describes the meteoric rise and fall of People Express and is widely used in management development programs to examine a broad range of issues in growth management, industry deregulation, human resources, organizational structure, and leadership. Beyond this similarity, the review also found key differences in the case problems and training strategies that are used in the four approaches.

The nature of case problems in the four problem-based approaches differs in two important ways. First, problems vary in their degree of structure. Problem structure can be described on a continuum of well structured to ill structured (Jonassen, 1997). Some approaches use problems that are more well

structured, meaning that the problems more clearly identify (1) the type of problem, (2) procedures for specifying solutions, and (3) one or several right solutions (Frederiksen, 1984). Other problem-based approaches use more ill-structured problems, meaning that (1) the exact nature of the problem is unclear and that some information, but not enough to solve the problem, is provided, (2) more than one way to solve the problem exists, and (3) the problem does not have a single right answer (Barrows, 1994).

Second, some problem-based approaches use prototypical problems more than others do. Prototypical problems are examples of routine problems seen in practice that contain high numbers of critical features (for example, signs, symptoms, and causes) in common with other examples of that type of problem (Mandin, Jones, Woloschuk, and Harasym, 1997).

The training strategies in the four problem-based approaches were also found to differ, with some being more expert-oriented and others being more learner-oriented. The determination of orientation was made by examining the type and sequencing of training events that are used in each approach and who is responsible for carrying out those events (Smith and Ragan, 1999). Differences in the four problem-based approaches relative to the aforementioned features of case problems and training strategies are detailed in this section and summarized in Table 1.

**Case Study Approach.** Long structured cases are generally used in the case study approach to actively involve participants in the problem-solving process (Birchall and Smith, 1998; Fulmer, 1992; Harling and Akridge, 1998). A long structured case consists of a rich written account of a problem situation. This account details relevant facts, constraints, extraneous information, and conflicting viewpoints of people involved in the situation (McWilliam, 1992), and it includes ancillary materials such as diagrams, charts, financial reports, memorandums, and market data (Graham, Morecroft, Senge, and Serman, 1992). Procedures for solving a case problem are generally prescribed for trainees prior to or during the analysis of the problem. As problem analysis progresses, trainees are guided toward one or several appropriate solutions. Therefore, in the case study approach, the problem situation is generally framed for trainees, procedures for specifying solutions are provided, and trainees are led toward one or several best solutions (Gallagher, 1997). Because of these structural features, problems in the case study approach are described as being fairly well structured. Whereas some authors, such as Acovelli and Nowakowski (1994), assert that cases in the case study approach should be prototypical of problems routinely faced in practice, widespread support for this belief was not found in the literature.

The training strategy used in the case study approach is the most expert-oriented of the four problem-based approaches (Marsick, 1990a). The objectives for a case study are generally shared with trainees at the onset of training. Trainees engage in the (1) discussion of the basic facts of the case, (2) determination of which concepts and principles apply to the case, (3) listing and

**Table 1. Selected Features of Problem-Based Approaches to Professional Development**

Features	Case Study	Goal-Based Scenario	Problem-Based Learning	Action Learning
Structure of problems <i>Trainees responsible for:</i>	Well structured	Moderately structured	Ill structured	Ill structured
(a) Framing problem	No	Somewhat	Yes	Yes
(b) Selecting solution procedures	No	Somewhat	Yes	Yes
(c) Generating solutions	Somewhat	Somewhat	Yes	Yes
Use of prototypic problems	Varies	Yes	Yes	Varies
Instructional orientation	Expert	Combination of expert and learner	Learner	Learner
Instructional events	<ol style="list-style-type: none"> <li>1. Discuss the basic facts of the case.</li> <li>2. Determine which concepts and principles apply to the case.</li> <li>3. List and evaluate possible problem causes and solutions.</li> <li>4. Select a solution.</li> <li>5. Discuss solution implementation.</li> </ol>	<ol style="list-style-type: none"> <li>1. Identify the problem situation.</li> <li>2. Gather information about the problem situation.</li> <li>3. Apply information to solve the problem.</li> </ol>	<ol style="list-style-type: none"> <li>1. Frame the problem.</li> <li>2. Analyze problem causes, solution procedures, and possible solutions.</li> <li>3. Identify unknown facts and learning issues. Assign research tasks.</li> <li>4. Conduct research.</li> <li>5. Reflect on learning and apply new knowledge to the problem. Revise hypotheses about problem causes and solutions.</li> </ol>	<ol style="list-style-type: none"> <li>1. Frame the problem.</li> <li>2. Explore alternative solutions.</li> <li>3. Select and implement a solution.</li> <li>4. Monitor and evaluate results.</li> <li>5. Reformulate problem, if necessary, and reconsider solution alternatives.</li> </ol>

Format	Large group	Individual or small group	Medium-sized group	Medium-sized group
Delivery system	Face-to-face with some use of computer technology	Computer-based	Face-to-face	Face-to-face with some use of computer technology
Length of time required	Short	Moderate	Long	Long
Outcomes	Single-loop learning Near transfer of content knowledge and skill Ability to solve well-structured problems	Single-loop learning Near transfer of content knowledge and skill Ability to solve well-structured problems	Double-loop learning Near and far transfer of content knowledge and skill Ability to solve ill-structured problems	Double-loop learning Far transfer of content knowledge and skill Ability to solve ill-structured problems Address a high-impact organizational problem

evaluation of possible causes and solutions, (4) selection of a solution, and (5) discussion of solution implementation (Fulmer, 1992; Harling and Akridge, 1998). These five steps engage trainees in an experiential learning process whereby they experience and reflect on a problem, form an abstract understanding of the principles and concepts relating to that experience, and transform those new understandings into a plan of action for solving the problem (Swadesh, 1998).

Trainers guide trainees through this process by focusing the discussion on important issues, providing trainees with factual information and theory or pointing them in the right direction to find answers for themselves, guiding problem analysis activities, using group dynamic techniques to stimulate interest, and synthesizing what has been learned in the final debriefing (Romiszowski, 1995). Because a trainer is frequently asked to supply technical information during the analysis of a case, it is helpful for that person to possess expertise in the subject matter being addressed. For example, the Central Intelligence Agency uses its field officers as instructors in its case-based training programs so that the officers can share their extensive knowledge and experience with trainees (Shreeve, 1997).

The case study approach is generally conducted in a live classroom setting with a group of twenty to thirty trainees (McWilliam, 1992). However, some professional development programs have experimented with conducting case analyses via instructional and communication technology. Multimedia systems have been used to provide trainees with access to case information through links to Web sites and to present information in a number of formats, including text, verbal commentaries, graphics, and video clips (Birchall and Smith, 1998). Electronic communication systems, such as e-mail and chat rooms, have been incorporated into multimedia technology to facilitate case discussions. Some common problems cited with these electronic communication systems include difficulty in maintaining an overall view of the content and structure of previous discussions as well as difficulty in keeping trainees on tasks or topics that trainers want to focus on (Romiszowski, 1995).

**Goal-Based Scenario Approach.** In goal-based scenario, trainees are responsible for accomplishing a goal in a simulated work environment. The simulation begins with the presentation of the training goal and objectives (Kolodner, 1993). Trainees receive a minimum amount of problem information at this point. They are allowed to take a variety of paths to gather information and work toward their goal, but they must work with the information and paths that are specified by the simulation. A goal-based scenario ends when a trainee produces a product that closely matches one specified by the simulation. Because a goal-based scenario requires engagement in some problem-framing activities and because it provides a number of paths to take in deriving a solution and contains a limited number of model solutions, its problems are characterized as moderately structured. These moderately structured problems tend to be prototypical, representing common types of

work problems found in practice (Macpherson, Berman, and Joseph, 1996; Schank, 1994).

The training strategy in a goal-based scenario is somewhat more learner-oriented than the strategy in a case study. Trainees typically work independently or in small groups on a goal-based scenario and are responsible for performing a number of complex procedural tasks during the computer-based simulation. To accomplish these tasks, trainees gather and analyze contextual, procedural, and content information from computer-based resources, such as video clips and archived organizational records (Schank, Fano, Jona, and Bell, 1993a). Experienced consultants serve as trainers and are responsible for coaching trainees on technical and procedural matters during the simulation. Recognizing that coaching is a new, and often difficult, role for many experienced consultants, a learning coach is frequently used to help a trainer/consultant facilitate a goal-based scenario experience (Campbell and Monson, 1994).

The design features of a goal-based scenario are illustrated in Andersen Consulting's Business Practices course (Acovelli and Nowakowski, 1994). This goal-based scenario is available on CD-ROM, and its fifteen modules simulate interaction with a fictional client—Perrin Printing and Publishing. The simulation instructs a trainee to review the company's operations and create a plan to financially revitalize the company. The modules take a trainee to fifteen different departments, each with a corresponding task. For instance, in the product development module, a trainee must create a work flow diagram of how a book moves through the process, from the idea stage to the finished product. Trainees can control the system, including moving from one department to another at will. A hypertext reference system, containing detailed procedural and technical information, is included in the simulation. The goal-based scenario provides video feedback as trainees work, comparing their work with examples of approved products. Positive feedback is given to trainees as the products that they develop approximate one of the models specified by the system.

***Problem-Based Learning Approach.*** Cases in problem-based learning are more ill structured than either those used in a case study or a goal-based scenario. In problem-based learning, trainees acquire the knowledge and skills they need to identify, understand, and solve a problem as they encounter it (Galey, 1998). The following problem-based learning case, dealing with the handling of hazardous materials, illustrates the three structural features of an ill-structured problem: (1) the exact nature of the problem is unclear and some information, but not enough to solve the problem, is provided, (2) more than one way to solve the problem exists, and (3) the problem does not have a single right answer.

You are the supervisor of the day shift of the local [hazardous materials] unit. It is 6:00 a.m. on a cool autumn morning. You are sleeping when the phone rings. You answer and hear [someone say], "Come to the Clear Creek bridge on Route 15. There has been a major accident and you are needed."

Quickly, you dress and get on the road to hurry to the site of the emergency. As you approach the bridge, you see an overturned truck that has apparently crashed through the metal guardrail. It has lost one wheel and is perched on its front axle. You see “corrosive” written on a small sign on the rear of the truck. There is a huge gash in the side of the truck and from the gash a liquid is running down the side of the truck, onto the road, and down the hill into a creek. Steam is rising from the creek. All traffic has been stopped, and everyone has been told to remain in their cars. Many of the motorists trapped in the traffic jam appear to be angry and frustrated. Police officers, firemen, and rescue workers are at the scene. They are all wearing coveralls and masks. The rescue squad is putting the unconscious driver of the truck onto a stretcher. Everyone seems hurried and anxious [Gallagher, 1997, p. 15].

Ill-structured cases in problem-based learning are prototypical of problems regularly found in practice (Lohman and Finkelstein, 2000). In the medical field, for example, because pneumonia is recognized as more typical of respiratory diseases than hydrothorax, a problem-based learning case dealing with a patient battling pneumonia would be used to develop understandings of common signs, symptoms, causes, and treatments for respiratory diseases (Albanese and Mitchell, 1993).

A learner-oriented training strategy is used in problem-based learning to help trainees learn how to solve ill-structured problems. Training objectives are specified for problem-based learning but are not shared with trainees at the beginning of training, so as to avoid supplanting problem causes and solutions in the minds of trainees and thereby short-circuiting the discovery process (Dolmans, Schmidt, and Gijssels, 1995; Norman and Schmidt, 1992). The training strategy involves five main events: (1) a problem is presented to a group of trainees and the group attempts to identify the broad nature of the problem as well as facts, factors, and constraints associated with it, (2) trainees analyze underlying problem causes, solution procedures, and possible solutions, (3) trainees identify unknown facts and learning issues, identify learning resources, and divide up independent research tasks, (4) trainees conduct independent research, and (5) trainees reconvene, reflect on what they have learned, apply their new understandings to the problem, and refine and revise hypotheses about problem causes and solutions (Hmelo and Ferrari, 1997; Maudsley, 1999). This cyclical problem-solving process continues until one or several solutions emerge to form an appropriate conclusion to the problem (Barrows, 1996).

The conventional format of problem-based learning involves medium-sized groups of five to eight trainees and a trained facilitator (Lohman and Finkelstein, 2000). Trainees are responsible for determining what knowledge and skills they need to learn, gathering and analyzing information, and monitoring their progress through the problem-solving process (Galey, 1998). Trainers help trainees perform these problem-solving tasks by providing

(1) cognitive support in the form of asking questions about domain-specific knowledge and procedures needed to solve a problem, (2) metacognitive support through the asking of questions about domain-general topics related to planning, monitoring, controlling, and evaluating the problem-solving process, and (3) procedural support in the form of matching the challenge of the problem with the abilities of the trainees, monitoring the pace and progress of the group, encouraging all trainees to participate in the process, and assessing trainee performance (Gallagher, 1997; Hmelo and Ferrari, 1997; Schmidt, 1994).

**Action Learning Approach.** The last problem-based approach, action learning, also focuses on solving ill-structured problems (Marsick, 1990a). However, the problems addressed in action learning may be the least prototypical of all four problem-based approaches. This is because participants generally choose which problems to work on, and their decisions are based on the impact that problems presently have or may have on organizational performance. Examples of ill-structured problems that have been the focus of past action learning projects include the creation of financial and nonfinancial measures for assessing managerial performance and the design of organizational restructuring plans (Raelin, 2000). These two problems are classified as ill structured because they lack clear identification, procedures for specifying solutions, and one right solution. However, they are not necessarily prototypical of other work problems that action learning participants routinely face in their organizations.

Similar to problem-based learning, action learning has a strong learner-orientation. Its basic premise is that adults learn best through collaboratively working with, and reflecting on, actual problems that are meaningful to them (O'Neil and Marsick, 1994; Watkins and Brooks, 1994). The process of action learning is seen as a cycle, with phases of problem identification, solution exploration, solution testing, monitoring, and problem reformulation. Its focus is on problem finding and analysis. Often, problems are initially identified in technical terms but are reformulated in people terms. This reformulation takes place as group members try out solutions and, in the process, uncover hidden perceptions, norms, and expectations of people in the organization. These hidden perceptions, once made explicit and examined, make it possible to rethink the ways in which problems are framed and solved (Marsick, 1990b).

Action learning groups typically range in size from six to twelve people (Froiland, 1994). In some situations, groups consist of a single stakeholder for the work problem that is being addressed, with the rest of the participants coming from different businesses or functions within a company. These non-stakeholders are included to provide the group with fresh perspectives on the problem being addressed (Marsick, 1990a). In other instances, all group participants come from the same department or division of a company and have a stake in solving the problem (Froiland, 1994).

Because action learning requires examination of one's private beliefs and assumptions, it can be an unexpectedly difficult and emotional process (Marsick, 1990b; Weinstein, 1998). As such, it is a process that benefits from facilitation. A facilitator is responsible for providing an environment in which participants can make explicit their privately held beliefs, guiding participants in the examination of their beliefs, and questioning tacit assumptions shared by participants (Dixon, 1998; Watkins and Brooks, 1994).

## Discussion

The literature review found that problem-based approaches to professional development use different types of problems. Problems tend to be ill structured in action learning and problem-based learning, moderately structured in goal-based scenarios, and fairly well structured in a case study. Two of the four approaches, problem-based learning and goal-based scenario, use problems that are prototypical of common types of problems in practice. The literature review also found that problem-based approaches differ with respect to their training strategies. The case study approach uses the most expert-oriented strategy, goal-based scenario is a more learner-oriented approach, and problem-based learning and action learning are strongly learner-oriented approaches.

### ***Impact of Design Differences on Problem-Solving Skill Development.***

The identified design differences have important implications for the types of problem-solving skill outcomes that can be expected from the four problem-based approaches.

In the case study approach, trainees are seldom responsible for problem framing, since rich information about a problem situation is typically provided in a case (Smith, 1987). This feature of case study approach is particularly of concern, because all too often the wrong problems get addressed in organizations, especially when problems are ill structured, complex, and involve many stakeholders (Marsick, 1990a). Furthermore, the case study approach tends to be expert-oriented, with solution procedures, technical information, and a range of acceptable conclusions for case problems provided by trainers or other information sources. This directed guidance diminishes trainees' engagement in cognitive tasks related to problem analysis (Raelin, 2000). In sum, the case study approach limits trainees' engagement in problem framing, specifies various solution procedures for trainees to use, and limits the range of acceptable solutions. As a consequence, it is likely to promote single-loop learning (Bridges and Hallinger, 1997). Single-loop learning results in the detection and correction of a problem "without changing the underlying policies, assumptions, and goals" of the problem (Argyris, 1980, p. 291). This type of learning promotes the ability to apply newly learned knowledge and skills to work problems that are highly similar to those encountered in training. In other words, it fosters problem-solving skill in well-structured domains.

The goal-based scenario approach is also likely to result in single-loop learning, although for slightly different reasons from those of the case study approach. A goal-based scenario contains an indexed database of contextual, procedural, and technical information related to a problem. Trainees receive instruction and guidance in navigating through this database as they attempt to achieve the goal of the simulation. Because a goal-based scenario operates on the assumption that trainees will accept rather than question the goal, assumptions, and information provided by the simulation, it is likely to result in single-loop learning. Therefore, a goal-based scenario enables trainees to apply the knowledge and skills they acquire during training to highly similar work problems; that is, it fosters problem-solving skill in well-structured domains.

Conversely, problem-based learning and action learning are more likely to result in double-loop learning. In problem-based learning and action learning, participants are responsible for framing problems, selecting and accessing learning resources to gather information, and generating and testing hypotheses about problem causes and solutions. These activities promote double-loop learning by involving trainees in the critical examination of a problem's underlying assumptions, procedures, and goals (Argyris, 1980; Raelin, 2000). Previous research has shown that individuals apply the problem-solving and cognitive skills they learned in problem-based learning and action learning when attempting to solve subsequent work problems of a highly ill structured or unfamiliar nature (Chang and others, 1995; Gallagher, 1997; Marsick, 1990b).

There is a subtle trade-off between problem-based learning and action learning in relation to developing problem-solving skill in ill-structured domains. In problem-based learning, trainees generate multiple hypotheses about problem causes and solutions, develop an inquiry strategy to gather additional information, analyze data, affirm or revise hypotheses, and select and implement solutions. This process is called *hypothetico-deductive reasoning*, and it helps people develop schemata of certain types of problems (Barrows, 1994). Schemata are activated during problem solving and enable quick movement from the identification of a problem to the selection and implementation of solution procedures. Therefore, the instructional steps of problem-based learning mirror the hypothetico-deductive reasoning process and the result of problem-based learning is the development of schemata. An issue that emerges from this understanding is that it is possible that the use of prototypical problems in problem-based learning leads to errors in problem solving with less experienced professionals. Because less experienced individuals possess more superficial understandings of problem features, they have a tendency to incorrectly place novel problems in the same category as those they have encountered in training. Incorrect classification leads to the inappropriate activation of a schema and the incorrect selection of a solution (Barrows, 1994).

No evidence was uncovered in this literature review to suggest that the incorrect classification of problems is a concern associated with action

learning. Two features of action learning may help to explain why this is the case. First, action learning is typically used with more experienced managers. Experienced managers generally possess fairly sophisticated schemata and, in all probability, they are not as likely to incorrectly classify problems based on superficial features. Second, action learning does not focus on prototypical problems as the basis for learning. As a consequence, even if less experienced professionals did engage in action learning, it is possible that they would be less likely to encounter superficially similar problems in practice and would be less likely to activate inappropriate schemata during problem solving.

***Design Issues Associated with Problem-Based Approaches.*** Aside from problem-solving skill development, there are advantages and disadvantages associated with each of the four problem-based approaches, in relation to developing and implementing professional development programs.

To begin with, the development of case problems is a resource-intensive undertaking in case study, goal-based scenario, and problem-based learning programs. Case problems take a substantial amount of time and expertise to write. Case writers must conduct background research, consult subject matter experts, and synthesize case information. The extensive amount of time required to perform these case writing activities is frequently cited as a deterrent to using a problem-based approach (Chang and others, 1995). However, this issue does not apply to action learning, because it does not generally involve extensive development of written cases before participants engage in the action learning process.

In addition to case design, problem-based approaches that use computer technology, such as goal-based scenarios and some case studies, incur enormous costs in the development of multimedia resources and simulations. Indeed, Schank, Fano, Jona, and Bell (1993b) report that

Even with the aid of tools, the development of such [goal-based scenario] software seems prohibitively expensive for most courses. Much of the problem lies in the fact that traditional tools do not address the most difficult aspects of developing such software: the proper coverage and representation of the content to be used, and the appropriate way to package this content in an instructionally effective manner. . . . Because the bulk of development time is spent performing tasks related to the analysis, such as specification and entry of content, facilitating these tasks seems to hold the greatest promise of rendering the development of goal-based scenarios economically viable [p. 338].

To increase viability, Schank and his colleagues are working on content-rich tools and scenario template tools that allow material and scenarios in a goal-based scenario to be reused. Until design tools such as these are developed, the use of computer-based instructional technology will be limited to professional development programs with extremely generous budgets and front-end timelines.

Development is only one hurdle in designing a successful problem-based approach to professional development. Another hurdle is successfully implementing the program. Successful implementation of a problem-based approach depends on three factors. First, the availability of time for training must be considered. All the problem-based approaches require greater amounts of training time than directive forms of instruction, but some of the approaches require less time than others, with the case study approach requiring the shortest amount of training time. Most professional development programs devote from an hour to a half day on a case analysis, whereas the goal-based scenario approach requires more training time. Simulations typically last from one to three days. Because participants require time to conduct group problem-solving and independent learning activities, problem-based learning and action learning are more time-intensive than the two previous approaches. Problem-based learning programs typically last from one to four weeks, whereas action learning projects generally last from three to twelve months. Some program designers have experimented with condensed forms of problem-based learning and action learning to diminish the time problem. However, Marsick (1990a) asserts that these condensed programs do not provide sufficient time for individuals to realize many of the benefits that can come only when a team wrestles with a problem over a longer time period.

A second factor related to the successful implementation of a problem-based program is the cost associated with its training format and delivery system. The case study approach is fairly inexpensive to implement because it uses large groups and requires only one trainer and one classroom facility. Goal-based scenarios, problem-based learning, and action learning are more costly because these approaches use smaller training groups, and each of these requires a facilitator and facility in which to meet. The goal-based scenario approach carries the additional cost of computer support.

A third factor related to the successful implementation of a problem-based approach is the skill of the trainers. Convention dictates that trainers be experts in the technical domain under study. However, previous studies of problem-based approaches have shown that technical experts tend to be too directive in small group discussions and so they short-circuit the problem-solving activities and cognitive learning processes of trainees (Albanese and Mitchell, 1993; Gallagher, 1997). For example, a study by Des Marchais, Bureau, Dumais, and Pigeon (1992) of expert versus nonexpert facilitators in problem-based learning found that in small group sessions, experts were more likely to talk (42 percent versus 31 percent of talk time), talk for a longer period each time they spoke (twelve seconds versus ten seconds), and suggest more agenda items (69 percent versus 11 percent) than nonexperts. Studies such as this suggest that the effectiveness of programs that focus on problem-solving skill development depends on the trainer assuming a facilitative role. This role requires expertise in methods of reflection, group communication, listening, and individual and group problem-solving and learning processes (Bierema, 1998).

**Implications for Designing Problem-Based Approaches.** Three implications for designing problem-based approaches to professional development clearly emerge from this review of the literature. First and foremost, the objectives of a professional development program should be the major determinant in deciding which type of problem-based approach to use. If the development of the ability to solve well-structured problems is identified as a program objective, then either the case study or the goal-based scenario approach is appropriate. If the development of the ability to solve ill-structured problems is identified as an objective, then either the problem-based learning or the action learning approach is appropriate. If, however, the resolution of a complex organizational problem is also an explicit objective of a program, then action learning is the optimal approach.

Second, the design of a problem-based approach must consider the resources that are required for development and implementation activities. In relation to development, budgets and schedules must take into account the extensive amount of time and expertise that are needed to develop case problems for case study, problem-based learning, and goal-based scenario programs. Additional time and expertise is also required to develop multimedia resources and simulations for goal-based scenario programs. With respect to implementation, program designers must consider the time, personnel, and training facilities that each problem-based approach requires. Case study and goal-based scenario programs require the least amount of implementation time, typically from a half day to three days. Problem-based learning programs require a greater amount of time, generally from one to four weeks, whereas action learning requires the greatest amount of time, with group projects lasting from three to twelve months. In relation to personnel and training facilities, the case study approach is fairly inexpensive to implement because it requires only one trainer and one training room. Goal-based scenario, problem-based learning, and action learning programs are more expensive because they use smaller training groups that each require a trainer and training facility in which to meet.

A third implication concerns facilitator training. Each of the problem-based approaches requires that a trainer use facilitation techniques to lead participants through the key steps of the problem-solving process. Since this form of facilitation is a new and challenging responsibility for many trainers, training should be provided to enhance their ability to provide cognitive, metacognitive, and procedural support during problem-solving activities.

**Future Research of Problem-Based Approaches.** Further research in four areas would deepen present understandings of problem-based approaches to professional development. First, further research of the role of independent learning activities in facilitating learning should be conducted. The case study approach is often the favorite choice of trainers because it requires the least amount of training time. In large part, this time saving is realized in the case study approach because trainees are not required to engage in independent

learning activities. More needs to be known about the trade-off between engagement in independent learning activities and the development of problem-solving skills.

Second, further study of the facilitator role in problem-based approaches is warranted. Areas for future research should include the influence of technical expertise in facilitating problem-solving groups, the role of cognitive, metacognitive, and procedural guidance during group problem solving, and the impact of facilitator training on trainers with varying levels of technical expertise.

Third, additional research focusing on the influence of computer technology on group problem-solving activities needs to be conducted. Some professional development programs deliver problem-based approaches through communication and multimedia technology, even though a substantial body of literature suggests that the effective performance of problem-solving and decision-making tasks requires information-rich media. Studies addressing the strengths and limitations of communication and multimedia technology for facilitating problem-solving activities would help clarify this disconnect between theory and practice.

Finally, previous theory and research indicates that problem-based approaches to professional development show much potential for promoting the problem-solving skills of professionals in today's organizations. However, relatively few empirical studies have examined ways of assessing higher-level cognitive outcomes in problem-based approaches. Most reports of problem-solving skills development have been based on subjective self-reports of trainees and assessments of trainers (Albanese and Mitchell, 1993). Finding objective ways to assess problem-solving skill is necessary to gain a more complete picture of the role of problem-based approaches in promoting the development of professional expertise.

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