DEVELOPMENTAL GUIDE

A DEVELOPMENTAL GUIDE TO ASSESSING AND OPTIMIZING PROFESSIONAL PROBLEM SOLVING

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Cindy Lynch can provide:

- consultation about your questions and ideas
- training for designing problem solving exercises and evaluating responses
- information about the availability of computer scored measures for group assessment
- training and certification for using the Reflective Judgment Interview
- psychometric and other research data

Note: The authors periodically update this manuscript. Future versions of this paper (possibly re-titled) can be downloaded from Susan Wolcott's home page:

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Introduction

The urgent need for professionals who can "solve diverse and unstructured problems in unfamiliar settings" and "comprehend an unfocused set of facts; identify and, if possible, anticipate problems; and find acceptable solutions" (Arthur Anderson & Co. et al., 1989, p. 6) is well established across professions. Specific calls for better professional problem solving skills have come from employers, educators, and other practicing professionals (e.g., see Das, 1994; Ladesic & Hazen, 1995). Although many colleges, universities, and professional development programs assert that improved thinking and problem solving are important outcomes, the lack of theoretically grounded and empirically supported strategies to foster and assess the development of necessary skills significantly hampers our efforts. While we may be aware of some of the characteristics of the ideal for which we strive, as indicated in the quoted passages above, the steps between typical performance and desirable performance often remain unarticulated or vague, thus limiting our capacities to foster and assess skill development.

In this paper, we recommend a transdisciplinary approach that links the process of problem solving to two theories in developmental psychology. One theory focuses on sequences of skills and the importance of environmental factors in optimizing performance (Fischer, 1980; Fischer, Bullock, Rotenberg, & Raya, 1993). The other theory, the reflective judgment model of cognitive development (King & Kitchener, 1994), articulates a series of increasingly complex problem solving skills. The link to these theories is important because it provides us with a map for structuring our efforts to optimize professional problem solving.

This manuscript provides:

- TRANSDISCIPLINARY PROBLEM SOLVING MODEL: Description of a general problem solving model that maps neatly onto other problem solving, scientific inquiry, and decision making models.
- OBSERVABLE SKILLS: Definitions of a series of problem solving skills that constitute the problem solving process and require increasingly complex intellectual skills.
- EXERCISES: Examples and a template for designing problem solving exercises that are relevant to course content and provide data about individual and group performance.

- EVALUATION TOOLS: Tools to enhance the ability of educators and students to evaluate problem solving performance and examples of evaluated exercises.
- QUESTIONS FOR PROBLEM SOLVERS AND ACTIVITIES: List of general questions for problem solvers and learning activities that can be adapted and expanded for any educational environment, with attention to developmentally appropriate structure and sequence.
- HINDRANCES TO PERFORMANCE: Lists of beliefs that may hinder the problem solving performance of those who exhibit specific skill patterns. Engaging students in the problem solving process using course-specific or work related adaptations of the questions and learning activities can effectively challenge these beliefs.

These tools provide an integrated approach for assessing professional problem solving, fostering the development of necessary skills, and monitoring one's own and others' problem solving efforts.

Terminology Used in This Manuscript

The literature includes a variety of terms that are related to the type of problem solving we address in this manuscript: for examples, critical thinking, decision making, professional judgment, scientific inquiry, and learning to learn . For two primary reasons, we have chosen *not* to use the term ***critical thinking***. First, the term "critical thinking" can be misleading because it has often been used synonymously with logical reasoning, which is only *one* component of the set of skills we describe in this paper. Second, although the process can be applied to any problem fraught with significant uncertainties, our focus is on the complex types of problems that people address in their professional lives.[1] We believe that the term ***professional problem solving*** helps the reader understand this focus.

Within our focus on professional problem solving, we restrict our attention in this paper to people's approaches to unstructured or open-ended problems. ***Unstructured problems*** are those fraught with uncertainties that prevent a single solution upon which experts would generally agree. Such uncertainties might result from (a) the definition and scope of the problem, (b) the most appropriate interpretations of related information, (c) the range of solution options, and (d) the potential impact of various options. One can contrast unstructured problems with ***highly structured problems*** for which there is a commonly agreed upon correct answer.

The educational goal for highly structured problems is to learn to reason to the correct solution, whereas the ***educational goal for unstructured problems is to learn to construct and defend a reasonable solution***. Following are examples of each type of problem:

Highly Structured Problem	**Unstructured Problem**
Identify the elements in a chemical compound	Judge the adequacy of a given theoretical proposition in biochemistry
Calculate the mean of a set of test scores	Design a measure of student learning that is valid and useful
Reconcile the balance in a bank account	Decide how to invest retirement savings

In this manuscript, we refer both to a ***problem solving process*** and to ***problem solving skills***. When an individual has a problem solving skill, that individual has attained a level of expertise with some task related to the problem solving process. Skills include, for example, the ability to interpret evidence relevant to a particular problem from alternative points of view. We would say that an individual using a larger number of complex skills is likely to operate more effectively in the problem solving process (i.e., leading to more reasonable solutions) than an individual using fewer and less complex skills. Also, we introduce in this paper a ***process (i.e., model) for addressing professional problems*** that can be used as a framework for the identification and development of desirable skills as well the methodical coordination of those skills.

Developmental Approach

In this paper, we introduce a developmental approach to the learning and mastery of professional problem solving skills. The following analogy can be used to understand this approach. Suppose it is our goal to help an athlete attempt to become the best runner possible, perhaps competitive on a world class level. During the athlete's infancy and childhood, this goal is biologically unattainable. Yet, as a child the athlete learns important skills that are precursors to becoming a world class runner. First the infant learns to crawl, then to walk, then to run. Each stage of development lays the groundwork for the next stage. During adolescence, the

[1] Although our focus in this manuscript is on problems that professionals face, the model and skills we discuss also apply to decisions about personal and civic problems such as deciding how to allocate financial resources or make judgments when serving as a juror.

athlete can learn to improve his or her running skills. The degree of development is a function of biology and of specific training and practice. As an adult, the athlete might or might not develop into a world class runner. This also is a function of both biology and training. While "natural" talent is important throughout the athlete's running career, few athletes achieve world class status without appropriate coaching and sustained effort. Coaches can help the athlete achieve his or her maximum potential by appropriately challenging the athlete and providing specific feedback. Appropriate challenges are designed both to train and motivate the athlete. A good coach realizes that attempting to hold a typical college age athlete responsible for world class performance is unrealistic and can cause the athlete to lose the motivation needed for further development. Coaches can also help the athlete learn to monitor his or her own performance.

The development of professional problem solving skills is very similar to the development of running skills. While most people can obtain at least an elementary level of competence on their own, few individuals can achieve their maximum potential without appropriate training over an extended period of time. As pointed out by Kurfiss (1988), professors often assign unstructured tasks that require highly complex skills, but we often leave the acquisition of such skills to the students' "ingenuity, good fortune, and native ability" (p. 4). Professors need to understand that lower level problem solving skills provide a foundation for the development of higher level skills. The most powerful types of educational challenges are those that require students to focus primarily on development of the skills just above their current abilities. It can be dysfunctional to hold students responsible for performance that is too far beyond their grasp. Professors can also help students learn to monitor their own performance (often referred to as ***learning to learn***).

In this paper, we utilize two well-validated theories from the developmental psychology literature to help us understand the developmental sequence of skills that individuals must master to appropriately address unstructured professional problems. We will briefly discuss these theories after we introduce our depiction of the problem solving process.

A Process for Addressing Unstructured Professional Problems

In this section, we define a generic model that can be used to describe the process of adequately addressing unstructured professional problems. Our model is drawn directly from the sequence of core problem solving skills decribed in King and Kitchener's (1994) reflective

judgment model of adult cognitive development. Also, it maps very neatly onto other descriptions of professional problem solving, scientific inquiry, critical thinking, higher order reasoning, mature reflection, and decision making (see, for example, Dewey, 1933; Golub, 1997; Polya, 1957; Schoenfeld, 1985; Schon, 1983; Woods, 1994). Such descriptions often include four general phases: identifying, framing, resolving, and re-addressing the problem (Lynch, 1996). Below we define the core skills associated with each phase, and we briefly discuss how poor performance in the less complex phases of the process leads to weaknesses in the more complex phases (i.e., we help the reader understand the developmental aspects of the model).

Identifying the nature of the problem involves distinguishing between highly structured problems and unstructured problems by recognizing uncertainties associated with factors such as (a) the definition and scope of the problem, (b) the most appropriate interpretations of related information, (c) the range of solution options, and (d) the potential impact of various options. Failure to properly identify the nature of a problem (i.e., mistaking an unstructured problem for a highly structured problem) may cause one to inadequately explore the problem, which in turn can cause significant difficulties in articulating and appropriately justifying a solution as most viable.

Inexperienced problem solvers often see all information rather simply as either true or false and solutions to problems as either right or wrong. Such persons are likely to be looking for a single, correct answer to even complex, unstructured problems. They often use information in unrealistic ways (King & Kitchener, 1994). When confronted with the dilemma of choosing a college major, for example, they tend to want counselors to tell them which major is right for them or to administer assessment instruments that will provide *the answer* (Welfel, 1982). The same applies in educational settings. When faculty attempt to introduce ambiguities and unstructured professional problems in the classroom, they are often frustrated by the sincere pleas of their students: "Don't waste our time with this. Just tell us the right answer!" These students have failed to identify the unstructured nature of the problem at hand, and thus, they are very unlikely to adequately frame and resolve it.

Framing an unstructured problem means exploring the problem and related information as thoroughly as time and other resources permit. This includes (a) considering the complexities of the context in which the problem is situated, (b) understanding alternative viewpoints, (c) objectively and qualitatively evaluating evidence from different perspectives, and

(d) recognizing and compensating for one's own initial biases. Although gathering related information is important when one addresses a professional problem, learning to put it into helpful concept maps that aid in making sense of the information in a complex way is crucial. When skills, time, or other resources fail to provide for adequate framing, conclusions are likely to be ill founded and re-addressing the problem in an effective process is likely to be absent.

Some students acknowledge that enduring uncertainty exists, even among experts, but they may view knowledge and problem solving as merely a function of personal impressions. Instead of expecting authorities to provide the right answer, they are more likely to use what appears to be a mixture of whim and stacking up unexamined evidence to address unstructured problems and support their beliefs (King & Kitchener, 1994). For example, their decision about an academic major may be based on what they express as an intuitive feel for what is best for them as individuals. When pressed to further justify their choices, they may focus on particular factors such as their past academic performance or salary expectations to the exclusion of other important factors (Welfel, 1982). These persons evidence a lack of skills that are necessary for constructing a complex framework from which to objectively address the problem of choosing an academic major. In classroom situations, such students may argue that "nobody knows, so anything goes." They are likely to jump to conclusions without adequate consideration of evidence or alternative viewpoints. They believe that faculty, like themselves, have no objective basis for qualitatively evaluating responses to unstructured problems.

Resolving an unstructured problem means articulating, endorsing, and effectively justifying a solution as most viable. Following adequate framing of the problem, this requires identification and application of principles that can be used to adjudicate across alternative solutions. Weak resolving skills are likely to lead to weak re-addressing skills because the individual lacks principles against which to measure his or her progress toward better solutions or increasing confidence as a problem is re-addressed over time.

People may avoid taking a stand because they find it somewhat difficult to justify their own opinions and at the same time effectively counter the arguments for other viable options. Such people may exhibit very good identifying and framing skills, but they are unable to articulate the principles they might use to decide which solution is most viable. They may indicate that alternative solutions are equally viable. In addition, while such individuals can be skilled at identifying limitations of solutions, they are unlikely to view problem solving as a

process that involves re-addressing. For example, they may describe the pros and cons of several possible academic majors but have difficulty choosing one as the best choice. In classroom settings, such individuals are able to present coherent descriptions of a problem, identify issues associated with multiple perspectives, and present logical and qualitative analyses of evidence. On the other hand, they sometimes jeopardize class discussions that involve resolving unstructured problems because they tend to get "hung-up" on the framing phase. For example, such students might argue that it isn't appropriate to think about the solution to a problem until everyone agrees on definitions.

Re-addressing or re-solving an unstructured problem involves recognizing and addressing the limitations of a particular resolution. In many cases, professionals must devise strategies for gathering new information about the problem and evaluating the results of a particular resolution (Golub, 1997; Schon, 1983). When important new information is obtained, a reconsideration of the problem is needed. This also can be thought of as once again identifying the unstructured nature of the problem. The goal is to work toward better solutions or greater confidence in a particular solution as the process is repeated over time.

Many individuals fail to re-address unstructured problems because they see resolution as the ending point of the process. This view can cause individuals to fail to consider crucial new information or to establish plans for responding to changing conditions. For example, such individuals can articulate valid reasons for choosing a particular academic major, but they may not respond to new information suggesting that their academic major should be reconsidered. They may also have difficulty establishing plans to monitor decisions over time.

Figure 1 presents one way to illustrate this process. We generally think of the process as proceeding from identifying, to framing, to resolving, to re-addressing (identifying again). However, the double-tipped arrows indicate that the components of the process can be addressed in different sequences, depending on the individual problem solver's approach. While engaged in the process, problem solvers draw on a flexible body of personal knowledge, which is their own knowledge and understanding of a constantly growing body of information, including such items as rules and regulations, facts and other data, and expert opinions. Personal knowledge is enlarged when an individual becomes aware of information and attaches personal meaning to it. Although not depicted in Figure 1, it is also important to note that intuition and creativity can come into play at any time.

Although Figure 1 is helpful in gaining an understanding of the overall process of adequately addressing unstructured problems, this nonlinear depiction doesn't clearly demonstrate the sequence in which students are most likely to develop their problem solving skills. In designing educational interventions, we prefer to utilize the linear version of the model presented in Figure 2. This "stair step" version is particularly helpful to students and faculty because it represents the idea that each step in the process lays a foundation for the next step. As discussed more fully in the next section, individuals must learn how to perform well on the tasks associated with the earlier, less complex phases of the process before they are able to perform well on the later, more complex phases.

In designing Figure 2, we added an additional phase not clearly illustrated in Figure 1. ***Gaining well-structured (or prerequisite) problem solving skills*** involves acquiring knowledge and skills such as definitions and rules, calculation techniques, and so on. These skills have generally been the primary, if not sole, focus in formal education settings. For example, it is clear that analysis of information is seriously impaired when students have insufficient knowledge related to the problem.

We would like to add a few words of caution in the use of Figure 2. First, the way we actually address professional problems is much messier and less linear than simple stair steps. Because of this, some people reject the linear model as overly rigid and simplified. Nevertheless, the power of the linear depiction is its aid in understanding the sequential development of skills. Second, it is not necessary that problem solvers have all of the precursor skills and basic information *before* being presented with a particular unstructured problem. Skills can be learned as the need arises; in fact, an interesting and realistic problem often provides the motivation to learn new information and develop stronger problem solving skills (Postman & Weingartner, 1969). This is particularly true for the acquisition of difficult, but highly structured problem solving skills. Also, because the development of skills generally occurs slowly, it is helpful for students to be exposed to higher level skills while developing lower level skills. In our earlier analogy, this is similar to having average athletes observe and talk about world class performances. Such exposure can help to motivate and model future desirable performance. We further discuss these recommendations in a later section of the paper.

Linking the Problem Solving Process to Developmental Psychology Literature

The skills in the problem solving process described above do not develop automatically as we get older and accumulate more experience. Although adults are continually faced with unstructured problems, some individuals are better prepared than others to address such problems (Eyler et al., 1997; Halligan, 1997; King & Kitchener, 1994; Mann, 1997; Wolcott & Lynch, 1997). For example, data clearly indicate that most college graduates exhibit very limited skills for effectively addressing unstructured problems (Halligan, 1997; King & Kitchener, 1994; Mann, 1997). In this section, we discuss very briefly the theoretical and empirical support for our contention that the unstructured problem solving skills develop sequentially as depicted in Figure 2.

The first source of support comes from the reflective judgment model of adult cognitive development (King & Kitchener, 1994). The reflective judgment model describes a developmental progression of seven qualitatively different levels, or stages, of reasoning strategies that students may apply to unstructured problems as well as sets of assumptions about knowledge that underlie those strategies.[2] The model specifically addresses the type of thinking addressed in this paper — the ability of individuals to identify, frame, resolve, and re-address unstructured problems.

As summarized in Table 1, the skills for the problem solving process described in the previous section are clearly embedded in the scoring rules for the reflective judgment model (King & Kitchener, 1985/1996). In particular, the problem solving skills for identifying, framing, resolving, and re-addressing unstructured problems develop sequentially in Reflective Judgment Levels 4, 5, 6, and 7, respectively.

Over the last 20 years, researchers have validated the reflective judgment model using carefully designed longitudinal and cross-sectional data from both male and female college students. Thus, there is empirical support for its use in college-level coursework design (King & Kitchener, 1994, Chapter 6). In addition, the model has been reviewed favorably when

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[2] The term reflective judgment comes from Dewey (1933), who used it when referring to the reasoning that is required to propose a tentative solution to an unstructured problem. According to King and Kitchener (1994, chapter 2), the reflective judgment model is rooted in the work of Piaget ([1956] 1974), Harvey, Hunt, and Schroder (1961), Perry (1968), Broughton (1975), and Loevinger (1976). Because it is based on Piaget's work, those who are familiar with Bloom's Taxonomy of Educational Objectives (Bloom et al., 1956), may also recognize similarities between the sequence of skills and tasks outlined in this manuscript and that classic work.

compared to other available models. Pascarella and Terenzini (1991) described the reflective judgment model as "perhaps the best known and most extensively studied" (p. 123) model of adult cognitive development. Hofer and Pintrich (1997) reported it to be the "most extensive developmental scheme with epistemological elements… It has been widely used by others interested in the construct and may be most useful for educators who see reflective judgment as a desirable educational outcome" (pp. 102-103).

The second source of support comes from skill theory (Fischer, 1980; Fischer & Bidell, 1997; Fischer et al., 1993), which articulates underlying structures in human development and focuses on the necessity of collaboration between the person and his or her environment in the performance of increasingly complex skills. This neo-Piagetian model applies across domains of development (physical, emotional, cognitive, and social) and extends from infancy through adulthood. In recent years, skill theory has become very highly regarded among developmental psychologists, as indicated by its prominence in Volume 1 of the most recent *Handbook of Child Psychology* (Fischer & Bidell, 1997; W. Damon, series editor). Kitchener and Fischer (1990) discussed how skill theory maps onto the reflective judgment model, and the research reported in Kitchener, Lynch, Fischer, and Wood (1993) supports the relationship between the two models and the notion that performance in reflective judgment varies depending on how it is assessed.

Skill theory predicts that the core skills described in the problem solving process are self-scaffolding. This means that earlier phases in the process lay the foundation for performance in later phases. In other words, when performance in a particular phase of the problem solving process is poor, performance in subsequent phases also is likely to be poor. For example, if an unstructured problem is mistaken for a highly structured problem, performance in all higher phases (framing, resolving, and re-addressing) is also likely to be weak. If the problem solver recognizes the unstructured nature of a problem but does not adequately frame the problem, the resolution and attempts at re-addressing it are also likely to be weak.

The reflective judgment model and skill theory both suggest that we can expect students to develop unstructured problem solving skills in the sequence depicted in Figure 2. Dewey (1938/1963) and Fischer (1980; Fischer et al., 1993) both emphasized that developmentally appropriate experiences are necessary for development. Both stipulated that experiences may be judged based on the degree to which they (a) build on previous experiences and provide developmentally appropriate opportunities for the context and the individual to collaborate or

interact in producing optimal performance and (b) lay a foundation for further development. Our efforts at skill development are most likely to be successful if students are challenged to perform at levels just above their current abilities as they grapple with interesting and practical problems. Thus, it is helpful to utilize assessment techniques to evaluate our students' current skill levels so that we can design developmentally appropriate challenges. The next section describes a suitable classroom assessment technique and its use.

Design and Usefulness of Problem Solving Exercises

As discussed above, professors interested in developing their students' professional problem solving skills are most likely to be successful if they design coursework based on their students' current skill levels. In this section, we introduce a problem solving exercise that can be adapted for use in any setting.

Appendix A offers guidelines and a template for designing ***problem solving exercises*** along with several exercise examples (adapted from Wolcott & Lynch, 1997). The exercise can be designed to focus on any unstructured academic, professional, personal, or community problem. The structure of the exercise is based on King & Kitchener's (1994, 122) recommendation that professors pose an unstructured question and then ask students questions adapted from the Reflective Judgment Interview (copyright 1977, King & Kitchener). The interview questions are designed to elicit information about complexity of reasoning and assumptions about knowledge (details summarized in Table 2). The information obtained from these exercises can be used to make curricular and training experiences more effective and efficient (Wolcott & Lynch, 1997; Wright et al., 1997). Advantages of problem solving exercises include:

- Direct faculty involvement in design and evaluation
- Adaptable for focusing on salient, work- or course-related content
- Adaptable for providing different levels of support for optimal performance
- Document skills and educational outcomes related to critical thinking, professional judgment, problem solving, and learning to learn
- Identify assumptions about knowledge and justification of beliefs that might be hindering problem solving performance
- Based on well-validated developmental theories, so that results allow faculty and supervisors to better understand performance deficits and the next steps in skill

development; this allows them to be more deliberate in designing effective, developmentally appropriate curricula and training environments

- Excellent tool for discussion and learning; provides stimuli for developmentally appropriate feedback, discussion, and learning
- In conjunction with self-evaluation materials (discussed later in this paper), can be used to encourage self-monitoring of problem solving performance
- May be used to build professional problem solving portfolios
- Relatively cost effective

How to Evaluate Problem Solving Performance

We recommend that two different strategies be used to evaluate student responses to problem solving exercises. Below we describe each method and discuss the benefits of each. Appendix B provides more detailed instructions and tools for each strategy:

Review for Evidence of Core Skills in the Problem Solving Process: Professors can review each student response for evidence that the student has exhibited the skills associated with each phase of the problem solving process: (a) demonstrating sufficient background knowledge and highly structured problem solving skills related to the problem, (b) identifying the unstructured nature of the problem and factors that contribute to uncertainties, (c) adequately framing the problem, (d) reasonably resolving the problem, and (e) appropriately recognizing limitations/re-addressing issues. Appendix B provides a generalized evaluation form that can be used or adapted for grading, student feedback, or other assessment purposes.[3] The form asks professors to determine whether specific problem solving skills are exhibited ("No," "Weak Yes," or "Strong Yes") and to suggest ways that students could improve upon their performance. Use of this form can provide a relatively quick way to gain insights into the general performance of a group of students. For example, such evaluations might help a professor recognize that many students have failed to recognize the unstructured nature of the exercise problem, suggesting that the students as a group need to work specifically on this phase of the problem solving process.

Prior to beginning the student evaluations, professors may wish to review the problem in light of the problem solving process and outline the key points he or she would consider when

[3] The authors would appreciate receiving comments or suggestions for improving this form.

applying the problem solving process to the exercise problem. While this might appear to be a simple task, we have found that professors often have difficulty outlining major points broken down by phase of the problem solving process. In some respects, their expertise in addressing such problems makes some parts of the process, particularly identifying and framing tasks, somewhat automatic for the professor. This can be a very useful exercise for professors who wish to improve their understanding of the key areas where students might have difficulty in addressing the problem.

We have observed several significant benefits of using this evaluation technique. First, it is efficient because it can be used for both skill assessment and as a rubric for grading.[4] Second, it can be used to provide specific and very useful feedback to students. Third, it helps professors understand specific areas where students need additional training and assistance. Fourth, it can be used to measure improvements in student performance over time (within a single course or across the curriculum). In addition, the power of this technique can be heightened when used in conjunction with student self-evaluations, as discussed later in this paper.

Review for Evidence of Assumptions About Knowledge and Patterns in Reasoning: As discussed previously, the problem solving exercise includes questions adapted from the Reflective Judgment Interview. Those questions are designed to elicit information about students' beliefs about knowledge and reasoning patterns, which might hinder student problem solving performance. The relationships between beliefs and difficulties with specific skills necessary in the problem solving process are itemized in Tables 3, 4, 5, and 6. The students' responses can be compared to the prototypic reflective judgment profiles presented in Appendix B.

Although we do not recommend using this strategy for grading and explicit feedback purposes, it helps professors better understand why student performance might be weak by focusing their attention on the underlying beliefs that might impair student skill development. This type of information can be very beneficial in helping professors understand that poor performance does not necessarily result from students' poor attitude or work ethic. As we

[4] It can be difficult for professors to decide how to assign grades once they learn their students' current skill levels. Because it is probably unreasonable to expect high skill level performance, particularly among undergraduate students, professors may wish to establish some target level of satisfactory performance for a given course. This target might be based on actual data for students in a given course, or it might be based on some desired skill level for competency in the course.

encourage students to practice the skills described in this paper and think about addressing professional problems as a complex process, we are designing an environment in which their fundamental beliefs about knowledge and how to justify their opinions may be challenged. This can be a very emotionally charged situation! Anticipating and understanding students' concerns can be very useful as we work toward a developmentally appropriate learning environment that is both challenging and supportive.

Annotated Examples: Appendix C provides six annotated examples of qualitatively different student responses to problem solving exercises. The annotations discuss our evaluations of the students' efforts in light of the problem solving skills described in this paper and what we know about underlying beliefs and reasoning based on the reflective judgment model. One set of examples addresses the question of whether evolution is a "fact, theory, or just a theory;" the other set responds to a question about the best way to study.

Variation Among Students: Exploratory research has indicated that even in a single classroom, students exhibit a wide range of beliefs and problem solving performance. For example, Wolcott & Lynch (1997, figure 1) reported the following distributions of reflective judgment levels based on student responses to a problem solving exercise in two sophomore-level accounting courses:[5]

Student Reflective Judgment Level[6]	Earliest Expected Difficulty in Problem Solving Process	Proportion of Students Spring 1994 N=31	Proportion of Students Fall 1994 N=17
3	Identifying	16%	6%
3/4	Identifying/Framing	10%	0%
4	Framing	36%	53%
4/5	Framing/Resolving	16%	0%
5	Resolving	13%	18%
5/6	Resolving/Re-addressing	0%	0%
6	Re-addressing	3%	24%
Unratable	Not known	7%	0%

[5] The reflective judgment levels reported here are slightly higher than typically expected in a sophomore course, based on Reflective Judgment Interview data reported by King & Kitchener (1994). Other studies have shown University of Denver students to operate at higher levels than groups of students at other institutions. This difference across educational settings highlights the need for professors to assess performance in their own institution when designing coursework interventions.

[6] Ratings of 3/4, 4/5 and 5/6 resulted when students exhibited strong characteristics of more than one adjacent level. Unratable responses occurred when students failed to answer all of the assignment questions.

Wolcott (1998b) found, even in two sections of an MBA-level accounting course, that 15% of the students operated below reflective judgment Level 4. In other words, those graduate students failed to recognize that the unstructured problem posed in the exercise was unstructured. They asserted that the problem had a single, correct solution. Welfel (1982) illustrated the practical implications of such distributions in her descriptions of the different ways in which people think about the unstructured problem of their own career development. Strategies for addressing the developmental needs of students who exhibit different patterns of problem solving skills are discussed in the next section.

As depicted in Figure 3, an initial assessment of student performance can be followed by design of developmentally appropriate educational interventions, implementation, a reassessment of student performance, and so on. Note that this process follows the general problem solving process depicted in Figures 1 and 2. In other words, classroom assessment is a tool we can use while addressing the unstructured problem of designing coursework strategies. Just as we expect our students to use evidence to reach well-founded conclusions, educators can use assessment evidence to develop well-founded educational strategies. In the next section, we discuss ways that educators can use assessment information to design appropriate educational interventions for their students.

Fostering the Development of Problem Solving Skills

Given information about students' current approaches to unstructured problems, professors are in a better position to design coursework that will be more likely to benefit students. In Tables 3 (identifying), 4 (framing), 5 (resolving), and 6 (re-addressing), we provide a summary of the following for each phase of the problem solving process:

- Description of desirable student skills
- Student beliefs that might hinder problem solving performance
- Related questions for problem solvers
- Related activities for problem solvers

The related questions and activities for problem solvers can be used as part of a series of assignments to move students through the problem solving process step-by-step over time. Professors can use these to design homework, in-class activities, projects, and examination

problems. As a general guideline, we suggest that professors focus the majority of classroom effort at the skill level just above the median for the class.

For example, given the data reported above for the sophomore-level accounting courses, we would suggest focusing most of the course efforts on questions and activities related to framing the problem. However, given the large proportion of students who are unable to adequately identify the unstructured nature of problems, it would be desirable to also expend considerable effort on activities aimed at the identifying skills. In addition, it would be most beneficial to students with higher skill levels to practice resolving and re-addressing skills.

One way to efficiently address multiple skill levels is via the problem solving exercise introduced earlier. When debriefing such an exercise in class, the professor can structure the discussion beginning with the highly structured aspects of the problem and proceeding sequentially through to the re-addressing phase. In this way, all students are exposed to the entire process, and students operating at higher skill levels can model the process for students operating at lower skill levels.

Another way to approach skill development is to coordinate efforts across the curriculum by focusing on certain skills in certain courses. For example, Wolcott (1998a, 1998c) suggests, for an undergraduate accounting degree program, that introductory courses might focus primarily on identifying the nature of unstructured problems, intermediate courses on framing, and advanced courses on framing and resolving.

To maximize opportunities for students to develop desired skills, professors can provide students with even more explicit support. For example, professors can share the problem solving process, particularly as depicted in Figure 2, with their students. By talking with students about the process, linking specific activities to that process, and providing individualized feedback, students will develop a clearer “map” of expected performance. Such explicit support is likely to produce performance that is more complex than performance observed without explicit support regarding the problem solving process (Fischer, 1980; Fischer et al., 1993; Kitchener, Lynch, Fischer, & Wood, 1993).

As mentioned earlier, a common problem encountered by faculty is that they are experts in their field and may take the identifying and framing phases of the problem solving process for granted (Schon, 1991). Observations of teaching behaviors indicate that coursework activities associated with the identifying and framing aspects of the process often are neglected in

educational settings. This makes it difficult for our students to develop the questioning habits and skills that necessarily underlie sound resolutions to professional problems. Professors may find it a challenging task to articulate specific, helpful questions to ask students as they try to learn how to move more effectively through the process. Assistance with this issue is a central purpose of the present work.

Student Self-Evaluations of Problem Solving Performance

As discussed more fully in Wolcott (1998d), we ultimately need professionals who can monitor their own performance. An effective way to draw student attention to their own development is to ask them to perform self-evaluations of their problem solving performance. The self-evaluation form presented in Appendix D can be used for this purpose. The form is adapted from the one previously discussed and included in Appendix B. The form asks students (a) to evaluate their performance on specific problem solving skills on a three-item scale--"No," "Weak Yes," or "Strong Yes", (b) to mark where their papers demonstrate their performance whenever they answer either "Weak Yes" or "Strong Yes" to a question, and (c) to identify ways they could improve upon their performance.

One way to use this self-evaluation form is to have the students complete it in conjunction with class discussion of an unstructured problem (either a problem solving exercise, as discussed earlier, or another type of assignment). Professors are likely to find that it is easier to evaluate a student's problem solving performance when reviewing the student's self-evaluation form and marked-up paper. The professor then can provide information about his or her expert evaluation, and the professor and student can compare their evaluations.

This technique can be particularly useful in helping professors understand the specific areas where students most need assistance. For example, one professor recently learned that many MBA students believed that citation in their papers of textbook definitions was sufficient for a self-evaluation of "Strong Yes" to the question, "Did you objectively evaluate the strengths and weaknesses of different pieces of evidence?" Although the professor had taught MBA students for more than 10 years and knew that many MBA students have difficulty in their attempts to frame unstructured problems, she did not anticipate this particular misunderstanding of what counts as strong evidence. Clearly, these students need to learn how to identify and use evidence beyond definitions in framing an unstructured problem.

Another way to use the self-evaluation form is to have students complete it before coming to class with a paper on an unstructured problem. This use would be particularly useful in courses where students are introduced to the problem solving process and are then given several assignments in which they can practice improving upon their performance.

Regardless of how the self-evaluation form is used, professors should anticipate that students might have difficulty appropriately evaluating their own performance. This is particularly true for students whose problem solving and analyis skills are relatively weak. If a student were unable to adequately recognize the nature of an unstructured problem, then we would expect that student to fail to understand the framing, resolving, and re-addressing aspects and, accordingly, be unable to appropriately rate his or her performance for those phases. This relates back to the developmental aspects of problem solving performance discussed earlier in this paper. We would expect students, with training, to be able to appropriately evaluate their own performance in the process at and below their current skill levels, and perhaps even at the next higher skill level. However, students will be less able to recognize the meaning of or to assess their own performance the further we ask them to go beyond their current skill levels.

Given our expectation that a typical college student (operating at reflective judgment Level 4) may be unable to appropriately evaluate his or her performance for framing, resolving, or re-addressing a problem, one might ask why we recommend using an evaluation form that encompasses all phases. As discussed previously, skill development is most likely to occur when students are given appropriate support. Such support includes exposing students early and repeatedly to future desired performance. In particular, repeated self-evaluations of problem solving performance throughout the curriculum can help students:

- Understand how assignments in different courses fit into the same overall problem solving process
- Apply skills to new settings through better recall and understanding (i.e., develop learning to learn skills)

Self-evaluation can also be used in conjunction with other forms of student reflection to further promote the learning to learn skills desired by many educators and employers. For example, Problem Solving Exercise Example 7 in Appendix B illustrates a reflection exercise that was used at the end of a course in which students were explicitly introduced to the

unstructured problem solving model and asked to conduct self-evaluations on earlier assignments.

Conclusion

This paper has introduced tools that can be used to assess and optimize professional problem solving. These tools have strong theoretical and empirical support from both skill theory (Fischer, 1980; Fischer & Bidell, 1997; Fischer et al., 1993) and the reflective judgment model of adult cognitive development (King & Kitchener, 1994). The information outlined in the figures and tables applies across academic disciplines and professions. Through asking our students to practice an increasingly complex series of skills for identifying, framing, resolving, and re-addressing unstructured problems – and through the use of appropriate questions and activities in supportive environments – we can improve the likelihood that student performance will improve over time.

We are very excited about our initial classroom experiences in adopting the suggestions made in this paper. Students respond well to the use of real-life cases and scenarios. They also appear to perform better and to have better attitudes toward unstructured problems when provided with support that is adapted to their current developmental levels.

This paper presents our current thinking and teaching strategies. We view it as part of a *continuous* work in progress in which we use many kinds of data to continually evaluate and improve our efforts. Thus, we are attempting to model the same re-addressing skills in our own curriculum development efforts that we are striving to help our students develop. We would be pleased to have you join us in a stream of activities to design, implement, and assess efforts to optimize professional problem solving performance, and we eagerly invite your questions, ideas, and anecdotes.

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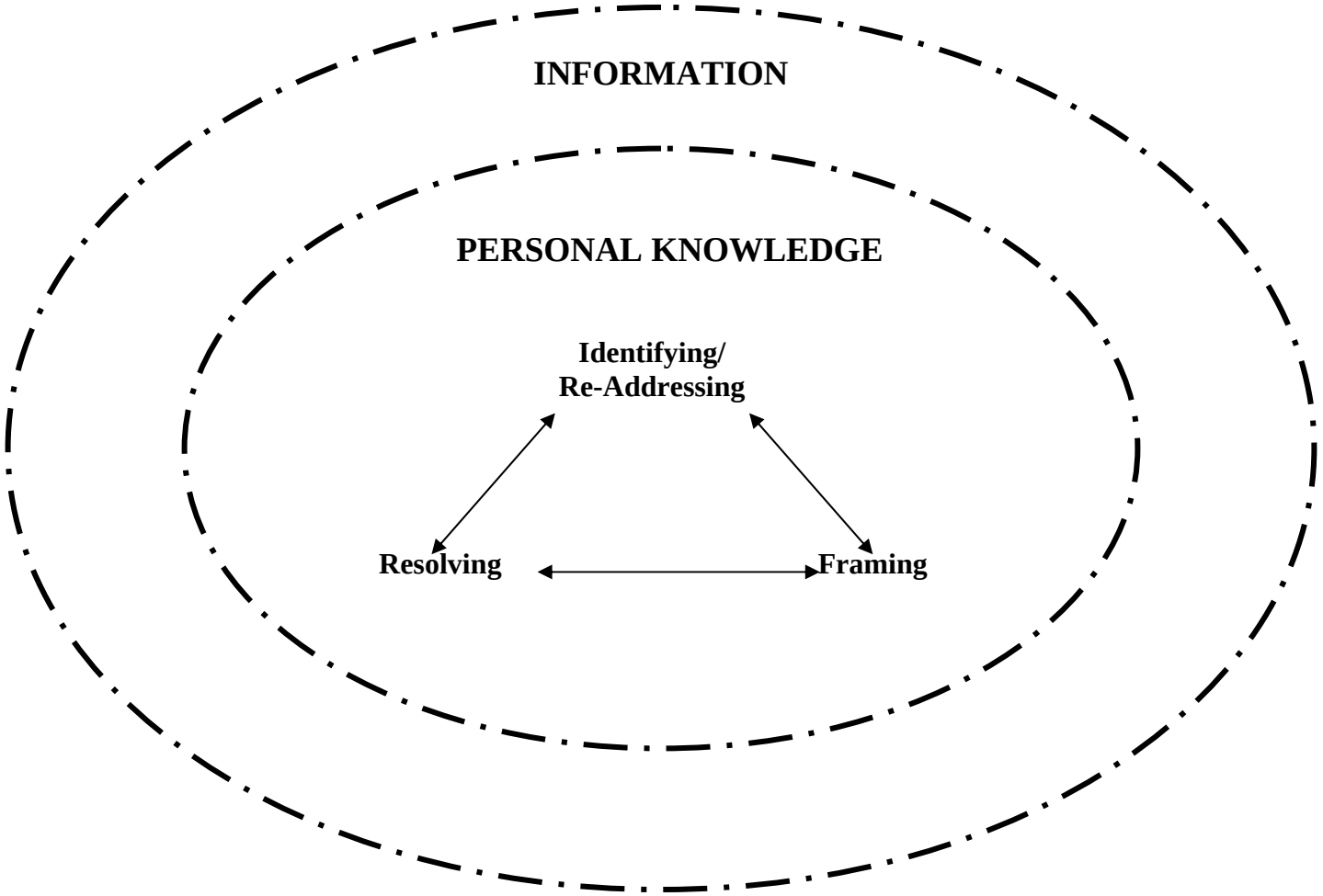

Figure 1: A transdisciplinary process for professional problem solving

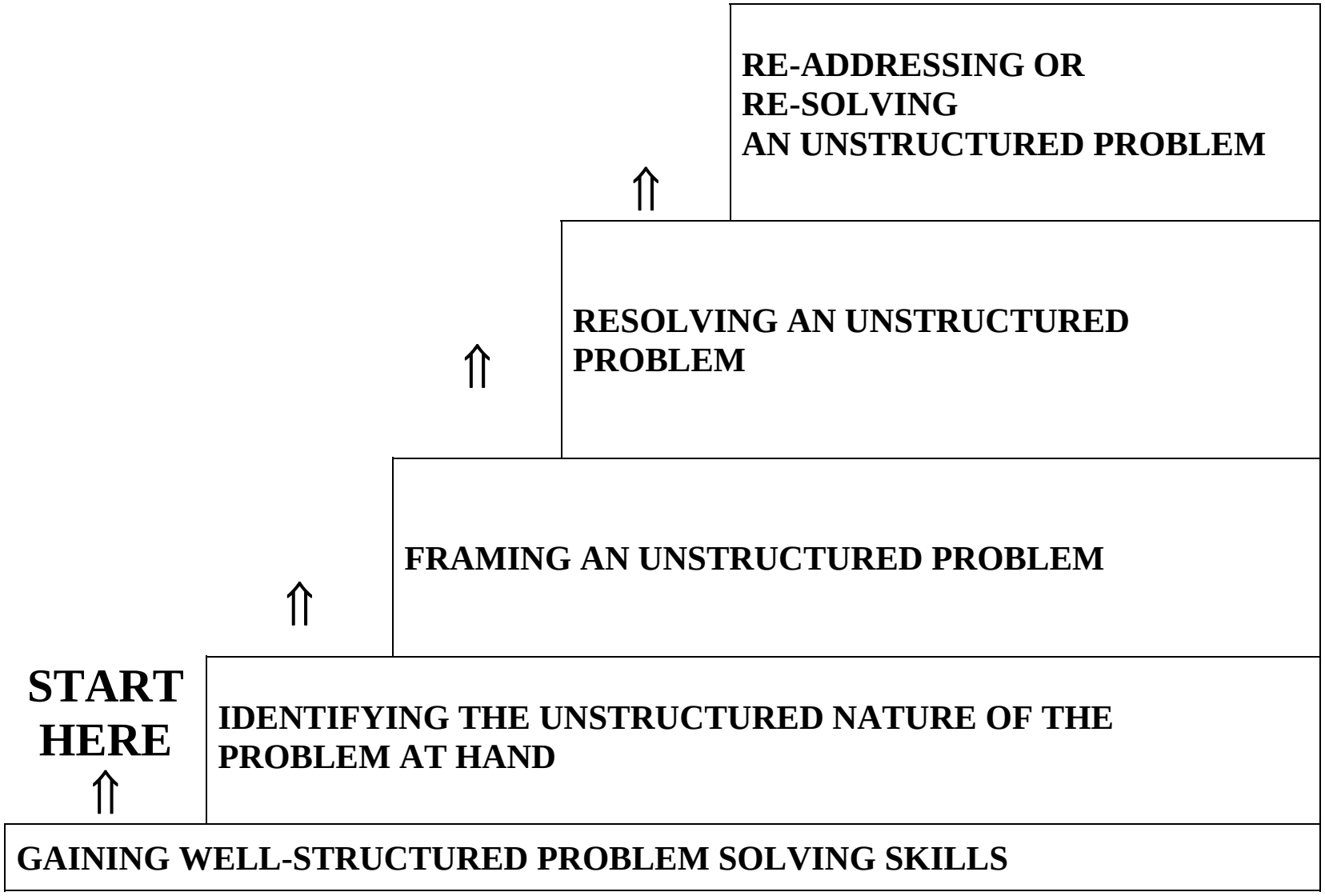

Figure 2: Linear version of a process for professional problem solving.

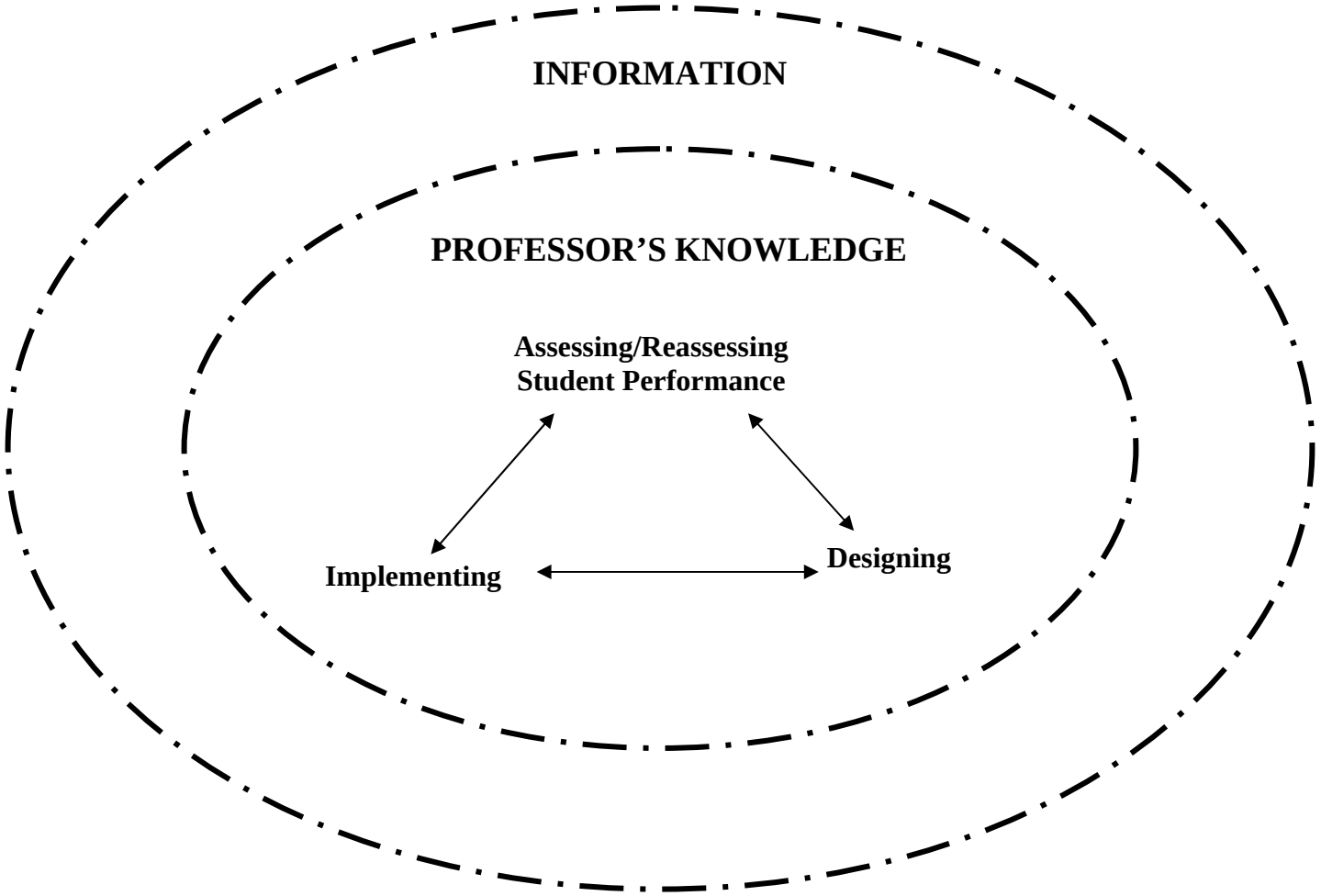

Figure 2: Assessing and designing educational interventions

Table 1: Reflective Judgment Levels and Patterns of Problem Solving Skills

Reflective Judgment Level				
3	**4**	**5**	**6**	**7**
Unable to identify unstructured problems, leading to weaknesses in all subsequent skills described in the problem solving process	Able to identify at least some unstructured aspects of a problem, but inadequate framing, resolving, and re-addressing	Able to adequately identify and frame an unstructured problem, but resolving and re-addressing skills are weak	Able to adequately identify, frame, and resolve an unstructured problem, but re-addressing is weak	Able to adequately integrate identifying, framing, and resolving skills to address unstructured problems in a coherent process over time

The above summary is based on the problem solving process definitions listed below and the authors' understanding of the scoring rules for the reflective judgment model (King & Kitchener, 1985/1996).

Problem Solving Process Definitions

- Identify: Distinguishes highly structured problems that have "correct" answers from unstructured problems that are fraught with significant uncertainties.
- Frame: For unstructured problems, looks beyond his or her personal perspective and initial assumptions; articulates the larger context of the problem, and makes legitimate, qualitative interpretations of relevant evidence from different perspectives.
- Resolve: Articulates and uses relevant principles for making sound professional judgments across options or perspectives; reaches a conclusion and provides a well-founded justification in light of other options.
- Re-Address: Coordinates identifying, framing, and resolving skills into a viable process that moves toward better solutions or more confidence in a solution as the problem is addressed over time.

Table 2: Reflective Judgment Interview Questions and Purpose

Probe Questions	Purpose
What do you think about these statements?	To allow the participant to share an initial reaction to the problem presented. Most respondents state which point if view is closer to their own.*
How did you come to hold that point of view?	To find out how the respondent arrived at the point of view, and whether and how it has evolved from other positions on the issue.
On what do you base that point of view?	To find out about the basis of the respondent's point of view, such as a personal evaluation of the data, consistency with an expert's point of view, or a specific experience. This provides information about the respondent's concept of justification.
Can you ever know for sure that your position on this issue is correct? How or why not?	To find out about the respondent's assumptions concerning the certainty of knowledge (such as whether issues like this can be known absolutely, what the respondent would do in order to increase the certainty, or why that would not be possible).
When two people differ about matters such as this, is it the case that one opinion is right and one is wrong? If yes, what do you mean by "right"? If no, can you say that one opinion is in some way better than the other? What do you mean by better?	To find out how the respondent assesses the adequacy of alternative interpretations; to see if the respondent holds a dichotomous either/or view of the issue (characteristic of the early stages); to allow the participant to give criteria by which she or he evaluates the adequacy of arguments (information that helps differentiate high- from middle-level responses).
How is it possible that people have such different points of view about this subject?	To elicit comments about the respondent's understanding of differences in perspectives and opinions (what they are based on and why there is such diversity of opinion about the issue).
How is it possible that experts in the field disagree about this subject?	To elicit comments about the respondent's understanding of how he or she uses the point of view of an expert or authority in making decisions about controversial issues (such as whether experts' views are weighted more heavily than others' views, and why or why not).

*If the respondent does not endorse a particular point of view on the first question, follow-up questions are asked.

From P. M. King and K. S. Kitchener, 1994, *Developing Reflective Judgment: Understanding and Promoting Intellectual Growth and Critical Thinking in Adolescents and Adults* (pp. 102-103). San Francisco: Jossey-Bass.

Table 3: Identifying the Nature of an Unstructured Problem

Core problem solving skill	• Distinguishes highly-structured problems that have "correct" answers from unstructured problems that are fraught with significant uncertainties (includes identifying the major factors or limitations that prohibit certainty about the best solution to or opinion about an unstructured problem)
Reflective judgment level 3 beliefs that may hinder performance	• Uncertainty either does not exist or is merely temporary • Knowledgeable persons or experts know or will find correct answers to all problems • Until experts can agree, opinions are equally correct or equally biased guesses • It is sufficient to view problems holistically without attention to realistic complexities
Related questions for problem solvers	• What information is available about the problem? [Make sure problem solvers have access to information indicating that knowledgeable persons do disagree.] • What potentially viable opinions or solutions to the problem can be identified? • Do knowledgeable persons have different opinions or disagree about the best solution to this problem? ◦ If not, look for more information. ◦ If so, why might they disagree? • Do you think knowledgeable persons can ever be certain about the best solution to this problem? ◦ If so, how do you know which one is correct? ◦ If not, why not? What factors contribute to the uncertainties surrounding the problem?
Related activities	• Gather information related to the problem • Consult experts and explore literature or other resources to investigate the range of possible solutions to or opinions about the problem at hand • Generate a list of the aspects of the problem in which uncertainty is a significant factor

Note for Tables 3-6. Skills and beliefs that may hinder performance based in part on information from *Reflective Judgment Scoring Manual With Examples* (1985/1996) by K. S. Kitchener & P. M. King (available from Cindy Lynch, 286 Lake Shore Drive, New Concord, KY 42076). Some of the related activities drawn from *Developing Reflective Judgment: Understanding and Promoting Intellectual Growth and Critical Thinking in Adolescents and Adults* (1994) by P. M. King & K. S. Kitchener, San Francisco, CA: Jossey-Bass.

Table 4: Framing an Unstructured Problem

Core problem solving skills	• Identifies evidence-based processes for examining the problem and potential solutions from a variety of perspectives • Organizes concepts and information into an objective, balanced picture of the problem and the larger context within which different perspectives fit • Makes legitimate, qualitative interpretations of evidence from different perspectives
Reflective judgment level 4 beliefs that may hinder performance	• It is sufficient to simply stack up evidence that supports one's opinion • Conflicting points of view for which evidence can be provided are equally valid • Uncertainty is due only to specific limitations such as lost or incorrect reporting of data, limited resources, or inability to correctly predict the future • Criticizing an argument is the same as criticizing the person who makes the argument • Experts are biased persons who are simply promoting their own agenda
Related questions for problem solvers	• What is the context in which the problem is found? • What factors should be considered in addressing this problem? • What connections do you see between the present problem and other problems with which you are familiar? • What are the strengths and weaknesses of various pieces of evidence related to the problem? • What are the arguments for and against each potential solution? • What assumptions and biases are embedded in different perspectives (including your own) on the problem? • How might you compensate for your own biases related to the problem? • How might you organize the factors and information so that they are useful as you think about the complexities associated with the problem?
Related activities	• Talk with people who hold views that are different from your own. Articulate assumptions and biases that you hold in common and ways in which your thinking differs from theirs. • Practice developing a variety of frameworks or concept maps for organizing information and exploring the complexities and the problem's context • Discuss your ideas with others and consider their ideas; revise your framework as needed • Evaluate the quality of different kinds of evidence • Practice evaluating the same evidence and potential solutions from different perspectives

See Table 3 note for sources.

Table 5: Resolving an Unstructured Problem

Core problem solving skills	• Uses principles that apply across perspectives to choose rationally among potential solutions or opinions • Uses persuasive reasons and evidence to support assumptions and conclusions about most viable solution, and makes objective and substantial arguments to counter arguments that support other viable solutions
Reflective judgment level 5 beliefs that may hinder performance	• Endorsing one alternative denies the legitimacy of other alternatives • Problem solutions may be justified only within a given context or from a given perspective, making it very difficult to endorse and justify a solution as the best alternative • There are no overarching criteria by which to choose among competing evidence-based interpretations or solutions
Related questions for problem solvers	• What principles might you use to evaluate which solution option or opinion is best? • What are your objective, qualitative evaluations of related information and opinions? • Which solution is likely to be most viable? • What is your justification for this belief? • How have you compensated for any initial biases you might have had? Are those strategies adequate? • How would you respond to arguments that support other viable solutions?
Related activities	• Articulate how you use principles and frameworks for evaluating across perspectives or potential solutions • Write an essay in which you examine your reasoning in light of your initial biases and discuss how you have compensated for questionable biases • Explain how you would respond to arguments that support other viable solutions

See Table 3 note for sources.

Table 6: Re-addressing an Unstructured Problem

Core problem solving skills	• Recognizes most important limitations of the endorsed solution and their implications • Systematically employs processes of inquiry (problem solving) that lead to better solutions or greater confidence in the endorsed solution
Reflective judgment level 6 beliefs that may hinder performance	• Points of view about specific situations may be judged as better than others only in a very tentative way based on one's evaluations of experts' positions or the pragmatics of the situation at hand • There are no generalized principles and procedures that can be used to further investigate one's tentative resolution to the problem
Related questions for problem solvers	• What are the limitations of the solution? • What are the implications of those limitations? • Under what conditions would you need to reconsider your solution? • What strategies need to be implemented to monitor the results of the solution you have endorsed and revise as necessary?
Related activities	• Describe the limitations of the solutions and the implications of those limitations • Describe conditions under which you would reconsider the solution • If appropriate, devise and implement strategies for gathering new information that would necessitate a reconsideration of the problem

See Table 3 note for sources.

Appendix A

Designing Problem Solving Exercises, With Examples

Guidelines for Designing and Using Problem Solving Exercises

1. Pose an unstructured problem. The assignment should require students to form an opinion about an unstructured problem, for which there is more than one defensible position. The best topics are those already contained in course content and the professional practice environment. For example, educators gathered data for a FIPSE funded, service learning project by interviewing students about their views on the cause(s) and solutions for problems they were addressing in their current service learning activities (Eyler et al., 1997, see Problem Solving Exercise Example 5 in this Appendix for the interview questions). Students should be exposed to different points of view about the problem. This may be achieved in discussions and/or by assigning one or more readings that articulate different opinions. Alternatively, different points of view may be summarized in the assignment itself (see Problem Solving Exercise Example 6 in this Appendix).

2. Require answers to specific questions. Students should be required to (a) state their opinion and articulate the basis for their opinion; (b) state whether they think it is possible to determine if their opinion is correct and if so, how OR if not, why not; (c) explain why different points of view exist; and (d) discuss whether it is possible to determine if one or more opinions are better than others, and if so, how OR if not, why not. These questions are adapted from the Reflective Judgment Interview (see Table 2 for the interview questions and rationale for using these questions) and require students to articulate their thinking process; they provide information related to respondents' underlying assumptions about knowledge that is useful for assessing their performance from a developmental perspective.

3. Attend to student concerns about performance. Students want to perform well. When they are asked to form and defend an opinion about an unstructured problem, their concerns about stating an opinion different from the professor's may hamper their best attempts at framing and resolving a complex, unstructured problem. Because the purpose of the assignment is to obtain assessment information about the nature of their thinking process, we recommend that the grading criteria not be tied to their opinion, *per se*, but rather to their attempts at responding to the assignment questions. If the development of communication skills is a course objective, professors may wish to grade this aspect of the assignment.

4. Enhance the usefulness of the exercise. To capitalize on the assessment technique as a learning opportunity, students should receive adequate feedback.

- The assignments can be timed to coincide with class discussion of the topic, giving students an opportunity to learn how their peers addressed the questions.
- Students can be given individual written feedback, which might include comments and questions about the content of their essay as well as a critique of written communication skill.
- Professors can offer overall comments to the class when the graded essays are returned to students.
- Professors can seek student approval to distribute copies of two or three well-written essays depicting higher level cognitive development, to serve as models to other students. We recommend that more than one essay be distributed to provide students with examples of multiple ways in which the questions were addressed, with the professors' comments
- Students can be asked to perform self-evaluations of their own performance (see Appendix D).

Adapted from Wolcott & Lynch, 1997.

A General Template for Designing Problem Solving Exercises

Write an informal essay to answer to the following question. Your essay should be 1-2 pages, single spaced.

> [NOTE to Educators: Pose a meaningful unstructured problem: Insert reference to assigned reading(s) and/or summarize the unstructured problem/key issue.
>
> The assignment should require students to form an opinion about an unstructured problem, for which there is more than one defensible position. The best topics are those already addressed in the course or professional setting.
>
> Students should be exposed to different points of view about the problem. This may be achieved in discussions and/or by assigning one or more readings that articulate different opinions. Alternatively, different points of view may be summarized in the assignment itself. See Examples 1-7 on the following pages for a variety of approaches and issues.]

In your answer you must address each of these questions:

- 1. What is the basis for your opinion?
- 2. Do you think it is possible to decide whether or not your opinion is correct?
  - If yes, how? **OR** If no, why not?
- 3. How is it possible that there are differences of opinion about _____ [the key question]?
- 4. When people disagree about this issue, is one opinion right while the others are wrong?
  - If yes, how do you know which opinion is correct? **OR**
    If no, is one opinion better than the others?
    If one opinion is not better than the others, why not? **OR**
    If one is better, explain what you mean by better.

> [NOTE to Educators: These questions are adapted from King and Kitchener's (1994) Reflective Judgment Interview. See Table 2 for the rationale behind the questions asked in this exercise. These questions can be adapted and other questions, such as those in Tables 3, 4, 5, and 6 can be added to provide support for more complex problem solving performance.]

This assignment is worth ____ points. Points will be deducted if (a) you do NOT answer all of the questions, (b) you do NOT turn the assignment in on time, or (3) it is obvious that you copied your answer from someone else or you allowed someone else to copy your answer.

> [NOTE to Educators: Students want to perform well. When they are asked to form and defend an opinion about an unstructured problem, their concerns about stating an opinion different from the professor's may hamper their best attempts at framing and resolving a complex, unstructured problem. If the purpose of the assignment is to obtain initial assessment information about the nature of their thinking process, we recommend that the grading criteria not be tied to their opinion or justification, *per se*, but rather to their attempts at responding to the assignment questions. If the development of communication skills is a course objective, professors may wish to grade this aspect of the assignment.]

Adapted from Wolcott & Lynch, 1997.

Problem Solving Exercise Example 1: Evolution

(See Appendix C for our evaluations of three students' responses to this exercise.)

The following problem solving exercise was designed by Dr. Jim Platt, who teaches biology at the University of Denver, as part of a project funded by the National Science Foundation. The assignment was given to students enrolled in an undergraduate, natural science core course for nonscience majors. It focuses on students' perceptions of scientific theory, and it could be adapted for use in the social sciences and other disciplines. The reading assignment was a collection of quotations from scientists and others about evolution, prepared by Malcolm Jay Kottler under the title "Evolution: Fact? Theory? … or Just a Theory?"

ASSIGNMENT

After reading the attached article, you are to write a one to two page answer to the following question: "In your opinion, is evolution a fact, a theory, or just a theory?" In your answer you should address the following questions:

- What is the basis of your opinion?
- Do you think that it is possible to decide whether or not your opinion is correct? Why or why not?
- How is it possible that the scientists who are quoted in the article can hold such different opinions?
- Since it is obvious that scientists do have different opinions about this question, does this mean that one opinion is correct while the others are wrong? If not, is one opinion (or some) better than others? (If you do think that one or some opinions are better than others, explain what you mean by "better.")

This assignment is due at the beginning of your first laboratory. The assignment is worth 10 points. Points will only be deducted if: 1) you fail to answer all of the questions; 2) you fail to turn in the assignment on time; or 3) we are sure that you copied your answer from someone else or you allowed someone else to copy your answer.

Problem Solving Exercise Example 2: How to Study

(See Appendix C for our evaluations of three students' responses to this exercise.)

Electrical Engineering 231 Fall 96
Study Journal Requirements

Purpose: The purpose of this study journal is to help you reflect on your personal study habits. Throughout the semester, you've made required journal entries to include at least dated entries before GRs [graded reviews], after GRs, and a final comment about your feelings as you approach the final exam. The questions to be addressed are included below; however, only a brief discussion of each is required.

Final Assignment

You are to prepare a two to three page, typed, double spaced answer to the following question:

What are your current study habits and
how effective have they been in this course?

In your answer, you must address each of the following questions:

1. What, if anything, have you learned about your study habits this semester?
2. Have you made any changes this semester in how you study, take tests, or think/feel about your school work?

– If no, why not?
– If yes, what changes have you made and why? With what results?

3. What do you think is the best way to study? What is the basis for your opinion?
4. Do you think it's possible to know for sure if your opinion about the best way to study is correct?

– If yes, how do you know?
– If no, why can't you know for sure?

5. When people disagree about how to study, does this mean that one opinion is correct and the others are wrong?

– If yes, how do you decide which opinion is correct?
– If no, is one opinion better than the others? How would you decide which opinion is best?

What to turn in

– Include 2-3 page summary as outlined above
– Attach all study journal entries I am collecting data on the types of journal entries made in order to provide more guidance in the future. The journal does not need to be typed. Please don't waste time typing if you've done journal entries by hand.

This assignment is due by COB lesson 42, 10 December 1996. It is worth 3% of your final grade and replaces your previous study journal grade. Please answer as frankly as possible! Your grade is dependent on communication skills and whether you address all the questions – not on your specific answers to the questions.

Assignment developed by Lt. Col. Donna Peterson, US Air Force Academy.

Problem Solving Exercise Example 3: Program Evaluation

Evaluating the Effectiveness of Public Schools
A Guided Essay Assignment

Scenario

You are the leader of a community task force that has been asked to establish strategies for evaluating the effectiveness of the public schools in your metropolitan school district. The task force has received very different recommendations from two national experts. One focuses on the use of standardized, norm referenced test scores. The other includes a wider range of alternative indicators, such as curricular innovations, portfolios, and satisfaction ratings.

Task

Write a 1 to 2 page informal essay that addresses EACH of the following questions. You will receive 10 points if you respond to each of the questions.

You might want to make some notes first, and then write your paragraphs.

Questions

1. Why do you think experts might disagree about how to assess the effectiveness of public schools?

2. When experts disagree about how to assess the effectiveness of public schools, is one right and the other wrong?
    If YES, how would you know which one is right?
    If NO, is one opinion likely to be better than the other?
        If you believe the opinions are equally viable, what is the basis for your belief?
        If you believe one opinion is likely to be better than the other, how would you decide which one is better?

3. How might your task force proceed toward its ultimate task of establishing strategies for the evaluation plan in the face of conflicting recommendations?

4. What would you want to consider?

5. Why do you think this would be a good way to proceed?

6. Do you think we can ever be sure about the best way to evaluate the effectiveness of public schools?
    If YES, how could we be sure?
    If NO, why can’t we be sure?

Problem Solving Exercise Example 4: Financial Accounting

Below are several assignments created and used by S. Wolcott at University of Denver. Each of the assignments required students to also answer the reflective thinking questions (see the general template included in this Appendix).

Course	Reading(s) and/or Summary of Issues	Unstructured Problem
1. Third-Quarter Sophomore-Level Financial Accounting	Khalaf, Raula, "Fuzzy Accounting," *Forbes*, June 22, 1992, 96.	Should Chambers have expensed or capitalized its indirect development costs?
2. Senior-Level Introductory Auditing	Sternberg, William, "Cooked Books," *The Atlantic Monthly*, January 1992, 20-16; 35-38.	For whom do auditors work?
3. Master-Level Accounting Theory	• Miller, Paul B. W., "The Conceptual Framework: Myths and Realities," *Journal of Accountancy*, March 1985, 62-71. • Excerpt from: Buffet, W., Letter to Shareholders, Berkshire Hathaway Annual Report, 1988.	In your opinion, is the FASB's conceptual framework beneficial to financial statement users?
4. Intermediate Financial Accounting	For the last eight decades there has been an ongoing debate about the valuation of assets, especially property, plant and equipment, on the balance sheet. Current GAAP requires that companies report the original acquisition cost of their property, plant and equipment net of accumulated depreciation. Many people, including Walter Schuetze (former SEC Chief Accountant), have argued for reporting these assets at their current market value.	In your opinion, should the financial statements report property, plant and equipment at historical cost or current market value?
5. Master Level Accounting Theory	• "Historical Cost—Tale of a False Creed," commentary by R. J. Chambers, *Accounting Horizons 8(1)*, March 1994, 76-89. • "Mark to Market: The U. K. Experience," by Tom Lee, *Journal of Accountancy*, September 1994, 84-87. • Textbook(s) from prior financial accounting course(s): Sections discussing historical cost accounting.	Is historical cost the best measurement basis for assets?
6. MBA Introductory Financial Accounting	• Annual report of Safeway • Annual report of Ford Motor Company	In your opinion, which company has the greater risk that its contingent liabilities are significantly understated?

Problem Solving Exercise Example 5: Service Learning Interview

This is adapted from the format was used to gather data for a FIPSE supported service learning project. For more information, contact Janet Eyler at Vanderbilt University or the authors of this monograph.

We want to explore the way you think about the kinds of issues you will be involved with in your service this semester. Community problems are always controversial; people don't agree about what causes them, how to solve them, or even how we can know when we are on the right track. We want to explore your views AND how you arrived at them.

[Allow student to identify general issue he or she will be addressing in this semester's service learning activities.]

Sample issues:

Children: People in the community are concerned about children who are falling behind in school and those who eventually drop out before graduation. Evidence exists to support different opinions about why this is happening.

Homeless: People agree that homelessness is a problem for the community, but they disagree on why it has grown so dramatically in recent years.

AIDS: People in the community are concerned about the continuing spread of AIDS although they differ widely in their views about why it is a problem and why it continues to spread.

Youth Violence: Many people in the community are concerned about violence and crime committed by young people. There is disagreement about why this is a growing problem.

Poverty: In spite of many attempts to eliminate poverty, many people are poor. There is evidence to support several different views about why poverty has persisted and why it is a growing problem for children in this community.

CAUSES

- Briefly summarize what you think causes this problem. [follow-up probes as necessary, e.g., Anything else? Can you tell me more about that? Do other things contribute?
- How do you know these are the causes?
- On what do you based your view? [encourage justification]
- Can you ever know for sure that your position is correct? How? OR Why not?
- Let's explore some other possible points of view on this and what you think about those views. What are some other opinions about the causes of these problems? [if student can't identify competing views, interviewer may suggest]
- Why do people have different points of view about the factors related to this problem?
- When people have different opinions about causes, is one right and the others wrong?
    - [IF YES] How do you know which is right?
    - [IF NO] Is one better than the others?
        - [IF YES] What do you mean by better? How do you know it is better?
        - [IF NO] Why isn't one better than the others?
- What does it mean when experts have different points of view about the causes of this problem?

SOLUTIONS

- What should be done to try to solve this problem? What factors should be considered? Why? What information would need to be gathered? Why? How would you find it? What would you do with that information? What other resources would be needed? How would they be used?
- How confident are you that your approach would work? [IF UNCERTAIN] What are the reasons for uncertainty?
- What would you do to be more confident about the viability of your solution?
- What are some other opinions about possible solutions to this problem?
- Why do you think people have different views about how to solve the problem?
- When people disagree, is one solution better than the others?
    - [IF NO] Why not?
    - [IF YES] What do you mean by better? How would you decide which solution is better?

Problem Solving Exercise Example 6: Gender-Restricted Education

The following problem was developed by S. Wolcott and S. Muller for use near the end of the first course taken by students at The Women's College, University of Denver.

ESSAY ASSIGNMENT TO BE TURNED IN

In 1993, Shannon Faulkner challenged The Citadel, an all-male cadet corps, to accept her application to the program. Some people defend The Citadel's position in restricting the military school to male students, while other people argue that such a restriction constitutes discrimination.

Answer the following question (approximately one to two pages single-spaced):

As a student at an all-female college, what is your opinion on the above issue?

In your answer, you must address each of the following questions:

- What is the basis for your opinion?
- Do you think it's possible to know for sure if your opinion about this issue is correct?
  - ◊ If yes, how do you know?
  - ◊ If no, why can't you know for sure?
- When people disagree about issues such as this, does this mean that one opinion is correct and the others are wrong?
  - ◊ If yes, how do you decide which opinion is correct?
  - ◊ If no, is one opinion better than the others? How would you decide which opinion is best?

Problem Solving Exercise Example 7: Problem Solving Self Reflection

The following exercise was used by S. Wolcott at the end of a capstone Master of Accountancy course at University of Denver. It was adapted from Problem Solving Exercise Example 2 in this Appendix.

FINAL ESSAY ASSIGNMENT

Throughout the quarter, we've discussed ways to identify, frame, resolve, and re-address unstructured accounting problems. The following assignment is designed to help you reflect on your learning experience and to set the stage for your own self-monitoring and improvement in the future.

Answer the following question (approximately 2-3 pages single-spaced):

> **How did you go about addressing the unstructured question contained in your final project, and how effective is that approach likely to be for other unstructured accounting problems?**

In your answer, you must address each of the following questions:

- In one paragraph, describe the process that you used to address the unstructured accounting problem contained in your final project.
- Do you think it's possible to know for sure whether the solution you reached in your final project is correct?
  - ◊ If yes, how do you know?
  - ◊ If no, why can't you know for sure?
- When people disagree about a solution to an unstructured accounting problem such as your final project, does this mean that one opinion is correct and the others are wrong?
  - ◊ If yes, how do you decide which opinion is correct?
  - ◊ If no, is one opinion better than the others?
  - ◊ If you think that one opinion is better than the others, how do you decide which opinion is best?
- Did the structure we used in class (i.e., identify, frame, resolve, re-address) lead you to approach your final project problem in a different way than you have approached such problems in the past?
  - ◊ If no, why not?
  - ◊ If yes, what changes did you make and why? With what results?
- Do you expect the structure we used in class (i.e., identify, frame, resolve, re-address) to impact your approach to academic or professional problems in the future?
  - ◊ If no, why not?
  - ◊ If yes, what impact do you expect the structure to have? Why?

The assignment is worth 10 points. The assignment will be graded based on its full completion and on the apparent thoughtfulness of your responses.

Appendix B

Evaluating Performance in Problem Solving Exercises

Problem Solving Exercise Evaluation Student Name_____

No	Weak yes	Strong yes	Criterion for phase of problem solving process	Things I might have done differently
			Prerequisite knowledge: A. Did you identify the most important definitions, formulas, rules, theories, etc. that might be useful in thinking about this problem?	
			B. Did you identify various pieces of evidence about this problem?	
			Identifying: C. Did you identify a range of reasons why there is disagreement about this problem?	
			Framing: D. Did you explore the problem beyond your initial impression?	
			E. Did you consider how different people could interpret the evidence in different ways?	
			F. Does your paper demonstrate an organized and thorough analysis of the problem?	
			Resolving: G. In coming to your conclusion, did you objectively consider more than one alternative opinion/solution?	
			H. Did you explain how you weighed the important factors related to this problem in reaching your opinion/solution?	
			Re-addressing: I. Did you acknowledge the limitations of your opinion/solution and suggest ways to address those limitations?	

Prototypic Descriptions of Reflective Judgment Beliefs and Reasoning Patterns

Read the student's problem solving exercise paper and compare his/her beliefs and performance to the following prototypic descriptions. Identify the description that most closely matches the student's statements. Some students are likely to exhibit characteristics of two adjacent levels.

Reflective Judgment Level 3 -- Mistake unstructured problem for highly structured problem; not able to identify, frame, or resolve adequately.
Some people believe that the truth about some things is not known right now. Even authorities such as scientists and teachers don't have the truth. These people believe, however, that the truth will be found at some future point in time when more evidence is gathered. In the meantime, while evidence is incomplete, no one (including authorities) can claim to know beyond his or her own personal impressions or feelings. Because truth is unknown, beliefs can be justified only on the basis of what feels right or what an individual wants to believe at the moment. Different beliefs come from differences in feelings or differences in exposure to information. Such persons assume that some beliefs are true, some are false, and some are uncertain at the present time.

Reflective Judgment Level 4 -- Identify, but not able to frame or resolve adequately.
Some people believe solutions to unstructured problems can never be known with certainty. Uncertainty is always a part of knowing. Their reasons for this belief are concrete and specific, for example, a problem is too complicated for scientists to solve. They believe that there are many possible answers to unstructured problems but no absolutely certain way to judge among the answers. As a result, people can claim to believe something to be true for themselves, but others have the right to believe differently. Differences in viewpoint are seen as the result of differences in personality, upbringing, or bias. Therefore, what is true for one person is not necessarily true for the next.

Reflective Judgment Level 5 -- Identify and frame, but not able to resolve adequately.
Some people believe that knowledge must be understood within a context. In other words, beliefs are based on interpretations of evidence and data from a particular point of view. As a result, beliefs can be justified only from within a particular perspective, and well-founded judgments among competing perspectives or solutions cannot be made. Knowledge is based on subjective evaluations of evidence. Evidence and arguments are always interpreted through the person's particular perspective. Differences in points of view result from different interpretations. Differences in interpretation result from real differences in how people see the issue.

Reflective Judgment Level 6 -- Identify, frame, and resolve, but not able to demonstrate an integrated understanding of the on-going process of constructing knowledge.
Some people believe that it is never possible to know the truth in a general sense. People cannot know because knowledge comes through our senses, which are not perfect recorders of events. Individuals may nevertheless judge some beliefs as better than others. This claim is based on evaluating and comparing the opinions of experts and the evidence that is available about a particular problem. Based on such comparisons, these people argue that some points of view are less risky or seem better to them. They see opposing views as the result of different interpretations and placing different emphasis on the information available.

Reflective Judgment Level 7 -- Identify, frame, resolve, and demonstrate an integrated understanding of the on-going process of constructing knowledge.
Some people believe that although we can never know "truth" in an absolute sense, we can construct knowledge over time that is more and more useful in understanding reality. These claims are made by evaluating and synthesizing evidence and interpretations into a coherent explanation. Although such people agree that evidence is filtered through humans' different perceptions, they conclude that some interpretations are more reasonable than others. They suggest that a judgment can be justified as the best current solution to a problem, although a better solution may be constructed at a later date through the process of inquiry (science/reflective problem solving, etc.). Differences in points of view result from many interrelated factors, and different points of view may be judged as more or less reasonable.

Note. These prototypic statements were adapted from the Prototypic Reflective Judgment Interview, developed with financial support from the Spencer Foundation. See Kitchener, Lynch, Fischer, & Wood (*Developmental Psychology*, 1993, pp. 893-906) for more information.

Appendix C

Annotated Examples of Student Responses to Problem Solving Exercises

For the requirements for this exercise, see Appendix A, Problem Solving Exercise Example 1.

Evolution Student Example A	Evaluation Comments
Evolution in my opinion is a theory. I think this because there is **no solid evidence that proves this theory to make it a fact**. Research has been going on for quite a few decades to try to find out where man has come from. Some remains have been found of earlier life forms that have some modern day man features. There are still a few large gaps between time periods where there are no artifacts that prove we evolved over time. Tests have shown that monkeys do have the mental capability to learn, and that goes along with the theory of evolution. There is **always a way to prove that an opinion is right**. You can take the facts presented and look at the facts that are proven and compare them. An **opinion is usually based on facts**, so I think that my opinion **could be considered correct** because of what I just wrote. **No opinion is ever better than the other because they all have facts** that they have collected through research. There is **no way to prove which one is better. No opinion is wrong.** Evolution is a topic that will continue to be talked about for a while. It **will only be solved with a breakthrough**, by finding the missing link between the facts found already.	*Overall—Weak in all phases* *Cites evidence, but there is confusion about using evidence/facts to support an opinion. It appears the student has learned that one should use "facts" when defending an opinion (perhaps a sign of movement toward more complex performance), but evidence/facts are still viewed as concrete entities that are not subject to interpretation.* *Contradiction in logic: In one paragraph the student asserts you can prove an opinion is right with facts, followed by a paragraph in which she or he asserts that no opinion can be evaluated as better or wrong because "they all have facts." While this may appear illogical to us, it illustrates the belief that until we know for sure (in this case by collecting enough facts to fill the missing links), one opinion is as good as any other.* *The student believes we can know with complete certainty at some point in the future--fails to recognize the unstructured nature of the problem.*

For the requirements for this exercise, see Appendix A, Problem Solving Exercise Example 1.

Evolution Student Example B	Evaluation Comments
In my opinion, evolution must be a theory because to be a fact, it has to be proven. **Scientists have found evidence that supports the theory of evolution, but who can be sure**? We can find all the evidence in the world, but **no one was there at the beginning of time that could actually tell us**, so because we don't really know what happened, we couldn't say that it is a fact. I don't think that it is possible to decide whether or not my opinions on evolution are correct because as I stated before, **we know nothing for sure**. It doesn't surprise me that so many scientists have such different viewpoints on the subject because **everyone has his or her own sense of reality which is influenced by each person's own prejudices and experiences that have shaped his or her views**. For example, I grew up in a more religious background which has influenced me by causing me to doubt the whole theory of evolution more and be less open to it than others might be. Other people may have grown up in more atheistic environments and taught that the religious views on creation are ridiculous and that the scientific views on evolution are the only possibility, so they are more likely to support the theory of evolution. As I said before, I don't think that any one opinion on evolution is correct because nothing is proven. **Some opinions are better supported than others**, but because nothing is proven, I think it would be **difficult to say that they are "better" because they are better supported because again, we just don't know.** We don't know whether or not the theory of evolution is correct, and in my opinion, we will never know. Because it can't be proven, I think that it will always be one of life's great mysteries.	*Overall—Weak in Framing, Resolving and Re-addressing* *The student cites evidence and clearly understands that uncertainties are enduring. However, student asserts that certainty is limited only because "no one was there."* *Does not connect enduring uncertainty to assertions that "everyone has his or her own sense of reality."* *Impact of the interpretation of evidence on people's opinions is not understood complexly. Instead, student offers a single reason for differences of opinion: different backgrounds. Although this does affect how we interpret evidence, it is a rather simplistic statement that does not acknowledge how effective problem solvers interpret evidence as they reason to a conclusion.* *Partially reasoned-- "better supported" but unwilling to assert better supported view is better in a more general sense because "we just don't know."*

For the requirements for this exercise, see Appendix A, Problem Solving Exercise Example 1.

Evolution Student Example C	Evaluation Comments
In my opinion, evolution is a theory. This opinion is based upon the **comments within this article as well as on my own set of beliefs.** My definition of "theory" is based upon the comments of Simpson and Beck (p. 32). ". . . theories are not facts. They are **generalizations about facts** and explanations of facts, based on and tested by facts." At the same time, the notion of "fact" must be addressed within this definition. I contend that a **fact is something that can be observed with little subjectivity**. For example, the fact that the sky is blue cannot be disputed. However, some people may use different terms to describe the degree of "blueness" of the sky. Any **debate about the color of the sky must inevitably stem from the imperfections of our language**. In addition to this linguistic imperfection, the **inaccuracy of our perceptions** may also create debate about "facts." This is due to the assumption that all of our perceptions are equal and perfect. "The honest scientist, like the philosopher, will tell you that nothing whatever can be or has been proved with fully 100% certainty" (p. 33, Muller). For this reason, **my opinion can never be proved correct as it is based upon the subjective definitions that I have assigned for the terms "fact" and "theory**." Similarly, the debate within this article rests on linguistics and the imperfection of language. The scientists **do not have different opinions about evolution; they only disagree as to the degree of certainty with which evolution should be taught.** For this reason, I would deem the **better arguments the ones which recognize that this uncertainty exists**. "Better" in this case meaning **more easily accepted**.	*Overall—Weak in Resolving and Re-addressing* *Logically draws on content of the reading. Seems to understand theories as tools.* *Significantly more complex understanding of perspective and interpretation than Evolution Example B.* *Focus on definitions and differences in people's definitions (e.g., facts) and variations in interpretations of data (e.g., "the degree of blueness"--not yes/no, but rather in terms of quality or "degree").* *Understands differences in interpretations as necessary and valid. Reasoning goes something like this: "People's opinions are always relative to their perspective. My opinion is based on <u>these</u> definitions. From the perspective of these definitions, this is how I think about the problem.* *Differences in perceptions and subjective definitions preclude certainty.* *Does not use complex principles to adjudicate across perspectives. The only way to decide which is better is deciding which is "more easily accepted" [from my perspective, using these definitions]. The weight of the evidence across the views is not articulated as a significant guiding factor.*

For the requirements for this exercise, see Appendix A, Problem Solving Exercise Example 2.

How to Study Student Example A	Evaluation Comments
This semester I have learned that my study habits are **good according to the books** I have read. I don't know why my performance is not what it should be for a college student. I have learned that the harder I try the less pleased I am with the way things go. I find that if I don't put any effort into something then I am not disappointed when it does not turn out the way I expected.	*Weak IDENTIFYING, FRAMING, RESOLVING, and RE-ADDRESSING.* *Mystified about why "good" study habits have not produced desired results.*
I have made some minor changes in the way I study. I think I have done the homework more faithfully and I have set a four hour minimum time for studying before a graded review. Last year I used to go to bed at eleven regardless of what was accomplished. I thing [sic] these changes are good in the sense that every book I have read says that you need to study and some recommend high numbers of hours of study. I made the changes because my grades are not what they should be.	*FRAMING of the problem is very weak. Views the problem holistically. Focuses only on time/scheduling. (See Example C for a range of other considerations.)* *Thus, the students' skills in RESOLVING the problem and continually RE-ADDRESSING and making useful changes are also weak.*
The results of these changes have been dismal. I have not passed an EE graded review with flying colors yet I seem to do fairly well on quizzes and projects except for one which occurred during a bad week. **I have no idea how I would know if my opinion is the best opinion of studying. From books and my academic advisor indications are that I am studying the right way** and that I just need to give it time and things will work out. I feel that I am putting forth the effort needed to succeed. I don't know of too many people who can study for two hours a night each night before a graded review and then about four the night before and still manage to fail the graded review. I think it partly has to do with each person. Only you can make an honest assessment of your habits and how things are working.	*Indicates that according to the experts, "I am studying the right way." This suggests that the student's IDENTIFYING skills are weak. In other words the student does not have a strong grasp of the concept that the problem of how to study is one of those problems that does not have an absolutely correct answer. When this foundational skill is weak, FRAMING, RESOLVING, and RE-ADDRESSING skills are also very weak in most cases.*
One opinion about studying is no more right than another. Every person is unique and therefore each person needs to have a unique method of studying. However, there is an overall good method for studying. Reviewing a couple of nights in advance as opposed to cramming and relaxing when testing are two things that everyone should attempt. As for the specific way in which you study that depends on personality. The opinions of others should be used only when one is not satisfied with the results of their particular method of studying.	*Then says opinions are equally viable (despite what the books and academic advisor or experts say). This response contradicts the respondent's expectations that experts can supply information about the "right way" to study (previous paragraph) and suggests that the student is developing the skill of distinguishing between well-structured problems that have "correct" answers and unstructured problems.*

For the requirements for this exercise, see Appendix A, Problem Solving Exercise Example 2.

How to Study Student Example B	Evaluation Comments
The purpose of the study journal which I have been keeping for Electrical Engineering 231 has been to help me reflect on my study habits to date. Throughout various points of the semester, I have written entries pertaining to study skills. As the end draws hear, I must now analyze my current study habits, and how effective they have been in this course.	*Strong IDENTIFYING, but weak FRAMING, RESOLVING, and RE-ADDRESSING.*
I have learned a lot about my study habits this past semester. Up until entering to the Academy, I never had to study, and therefore had **really bad study skills** and habits. Good grades just came naturally. I was always able to balance school, sports, a job, a girlfriend, family, friends, and anything else that came my way without any major conflicts. I relied on what had transcended in the past to guide me through the future. With time, I learned this would not be the case. I would have to change my study habits if I was to get off academic trouble. I now know that **college is a whole different academic ball-game**. I must study a lot harder than I had ever had to. Admitting I had a problem with my study habits has been **the first step**, a step which I have taken this past semester.	*FRAMING is weak. Holistic response--bad/good.* *Talks about balancing other roles/demands, but sees different setting as only real difference that must be addressed.*
Due to my past performance, I have had to make changes this semester on who I study, take tests, and think/feel about my course-work. First off, I must devote a lot more time to my studies. I must remain caught up with my work, regardless of obstacles that may get in the way. I must set goals to achieve, and remain focused on the goals. Furthermore, I must not wait till the last minute to do that which I should have done earlier, for example completing big assignments and studying for exams. Although the progress I have made has not been immense, it has nonetheless been extremely beneficial to me. **I know that if I continue making progress,** I will be well on my way to becoming an academic giant.	*Primarily focuses on time/scheduling. (See Example C for comparison purposes.) RE-ADDRESSING? Although there are some references to changing study habits over time and a sense of process, this is NOT evaluated as strong RE-ADDRESSING skills because the FRAMING and RESOLUTION skills are weak.* *Personal experience only evidence cited.*
For me, the best way to study is by doing a lot of practice through repetitions. The reason behind my belief is due to **what I have learned through first hand experience**. It is not enough to know the material, it is also very important to be able to do it well and in a reasonable amount of time. Through experience, I now know that the only way to ensure that I don't run out of time on an exam is to practice, practice, practice. As the saying goes: **Practice makes perfect.** Aside from doing repetitious work, it is extremely important to **stay caught up** in order to avoid pulling all-nighters.	*Stacks up evidence (personal experience, grades) rather than exhibiting an ability to qualitatively evaluate a wide range of evidence. This is common among students who can distinguish between unstructured and well-structured problems but whose FRAMING skills are weak.*
I feel that it is **possible to know for sure** that my opinion about the best way to study is correct. **I have experienced the results first hand.** Although my study habits still have room for improvement, I feel that I am well on my way. For me, this is what works at the moment. There is nothing to say that this may or may not be the case two years down the road, but for now, **I am willing to stick with what seems to be working, and what seems to be correct.**	*Person is sure for himself. This "I can only know what is right for me" view is common among those who can distinguish between unstructured and well-structured problems but have difficulty thinking about problems with an adequately complex framework.* *Clearly IDENTIFIES the problem as an unstructured one. Asserts that all opinions equally viable because studying is an individual thing (weak RESOLVING).*
Although many people may disagree about how to study, no one person is correct, and no one person is wrong. No one opinion is better than any other. Different things work for different people. It is up to each individual to decide what is best for him or her.	

For the requirements for this exercise, see Appendix A, Problem Solving Exercise Example 2.

How to Study Student Example C	Evaluation Comments
After reviewing the notes taken after each lesson, several conclusions concerning my study habits can be made. I almost always look at the **syllabus** to see what will be covered in the **next lesson**. I at least **skim** the material and make an **assessment of what type of preparation will be adequate based on several criteria**, and I accomplish the homework if it is **feasible and necessary**. An accurate assessment of my study habits cannot be established simply by reviewing the notes taken for this class. I approach studying with a **cost-benefit analysis for all of my classes**. After checking the syllabi and skimming the material, I make an assessment of the **importance** of the homework for each class based on my **current grade** in each class, the **presence of a major graded event** in one or more classes, the likelihood of getting a **quiz** the following day in class, and my **current level of understanding of the material** covered. I really haven't made any changes in my study habits throughout the semester. I have **generally met with success** using the method described above and have only **modified it slightly in the past two years**. I am a little disappointed with my performance this semester in this particular class. Due to its concentration on problems rather than just concepts, one is required to work through a lot of problems in order to do extremely well. This is generally time consuming and looses [sic] out to other time demands. I believe that my method of studying is the **best method for me in a time demanding environment like the Air Force Academy**. Certainly, it would **need modification in another environment** where there was less of a time demand because it would probably be better to do everything assigned. I believe this is the **best study method due to the success** I have had using it in the past as well as this semester. It really **isn't possible to determine if my study techniques are the best available**. To be absolutely sure I would have to try several different techniques such as sacrificing sleep or leisure time to ensure I accomplished all assigned tasks or only doing homework in one or two classes a night and sacrifice another. Because **I have been successful with the techniques I have developed, I am leery to try new techniques for fear they would only hurt me.** When people disagree on how to study, **it does not indicate that one method is better than another. You have to consider the person and the environment to determine which opinion is best.** For example, a person who can retain information quickly and accurately may be better off spending a minimum amount of time studying for every class every night, whereas, a person who has to really dig into an assignment to understand it may achieve greater success if he/she ignores one class a night to provide time to work on others. **Given an unlimited amount of time**, I believe that it would be **best** for all students to accomplish all assigned tasks for every lesson in every class. However, this is an **impractical** study technique due to time **constraints** inherent to the Air Force Academy. This forces students to develop less than desirable study techniques that can still get the job done.	*Strong IDENTIFYING, FRAMING, RESOLVING, and RE-ADDRESSING. Contrasting this example with Examples A and B highlights the much more complex framework and on-going, systematic process this person uses to continually assess needs and establish priorities.* *Complex, balanced view of the problem-- The student's own construction of a PROCESS for FRAMING, RESOLVING, and RE-ADDRESSING this problem is clearly articulated.* *RE-ADDRESSING: Indicates has developed this complex approach over time--using results (degree of success) to determine when changes are needed* *Acknowledges the possibility of gathering even more evidence, but pragmatic in deciding not to pursue those ideas in current situation. I discounted student's use of the term "absolutely sure" because of the complex approach to the problem and because student acknowledged that the uniqueness of person/ environment interactions precludes a single, correct solution.* *RESOLVING: Best for person given particular environment--this is a principle that applies to both self and others (see below). This student's response is qualitatively different from Example B in terms of FRAMING, understanding that some RESOLUTIONS are generally better than others, and clearly articulating and justifying a viable process for continually RE-ADDRESSING the problem.*

Appendix D

Student Self-Evaluation of Problem Solving Performance

Self-Evaluation Form Name_____

One of the skills of a professional is self-regulation. This self-evaluation form will help you evaluate your efforts in addressing an unstructured problem.

The table below presents several evaluation criteria. For each criterion in the table (A-I): (1) Underline related passage(s) in your essay if you met the criterion and mark the passage with that criterion's letter (a single passage might relate to more than one criterion); (2) Place a check in the column below that represents your evaluation of your performance; and (3) In the right hand column, make notes about things you might have done differently.

No	Weak yes	Strong yes	Criterion for phase of problem solving process	Things I might have done differently
			Prerequisite knowledge: A. Did you identify the most important definitions, formulas, rules, theories, etc. that might be useful in thinking about this problem?	
			B. Did you identify various pieces of evidence about this problem?	
			Identifying: C. Did you identify a range of reasons why there is disagreement about this problem?	
			Framing: D. Did you explore the problem beyond your initial impression?	
			E. Did you consider how different people could interpret the evidence in different ways?	
			F. Does your paper demonstrate an organized and thorough analysis of the problem?	
			Resolving: G. In coming to your conclusion, did you objectively consider more than one alternative opinion/solution?	
			H. Did you explain how you weighed the important factors related to this problem in reaching your opinion/solution?	
			Re-addressing: I. Did you acknowledge the limitations of your opinion/solution and suggest ways to address those limitations?	