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Learning to Reason with Economics

Ronald L. VanSickle

Economics educators agree that one of the major goals of economic education is to teach students to reason effectively using economic knowledge in their public and private lives. Economic reasoning is a central feature of *A Framework for Teaching the Basic Concepts* (Saunders, Bach, Calderwood, and Hansen 1984), which is the basis of the Master Curriculum Guide in Economics produced by the Joint Council on Economic Education (JCEE). In a national survey of economics teachers, 90 percent selected "to prepare students to make intelligent decisions" as an important purpose of economic education (Yankelovich, Skelly, and White, Inc. 1981). The "five-step decision-making model" featured in the *Framework* has been implemented in several major economic education programs.

Research and development on teaching and learning higher-cognitive thinking skills (e.g., problem solving, critical thinking, decisionmaking) have increased greatly in recent years. Cognitive psychological research on problem solving has provided the basis for reconceptualizing the problem of teaching students to reason and for charting new instructional approaches (Gagne 1985). This work raises issues that economics educators should consider as they design instructional programs, develop curricular materials, and endeavor to help students learn and apply economic concepts and principles.

The goal of this article is to present a set of criteria for evaluating instructional programs intended to teach students to reason with economic concepts and principles. The evaluation criteria are developed from recent information-processing research on problem solving. Particular attention is given to a set of concepts cognitive psychologists use to distinguish between the different kinds of knowledge that experts use in solving problems in their fields of expertise. These concepts clarify how the thinking of experts and novices differ in a field like economics. They also clarify some of the tasks an expert must accomplish to teach novices (students in introductory economics courses) to think using economic knowledge. Implications of the cognitive psychological research on problem solving for designing and implementing instructional programs to teach students to reason with economics are identified.

Expert and Novice Problem Solvers

Voss, Greene, Post, and Penner (1983) compared the problem-solving thinking of experts and novices in the field of Soviet domestic affairs. Their

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study clarifies some of the differences between experts and novices in a field when they must solve a subject-matter problem. The novice problem solvers were taking their first course in Soviet domestic policies, and the expert problem solvers had earned doctoral degrees specializing in the Soviet Union. Specifically, Voss et al. posed the following problem: Suppose that you are the Minister of Agriculture in the Soviet Union, and assume that crop productivity has been consistently low for several years. Your responsibility is to increase crop production. How would you go about solving this problem (p. 174)? Each problem solver thought out loud and was recorded. Detailed protocols made from the recordings were analyzed and diagrammed in terms of the content and reasoning processes used by the problem solvers.

Voss and his colleagues (1983) observed clear differences between the experts and the novices. The experts began by reviewing the problem and analyzing the context of the problem, a process that led to a problem representation. They generally converted the given problem into another, more general problem, such as unconstructive priorities of the political apparatus or inadequate technological development. In contrast to the experts, the novices skipped the general analysis of the problem's context and quickly identified a set of specific subproblems, such as insufficient fertilizer, insufficient tractors, and harsh climate, that did not address adequately the larger issues underlying the subproblems.

The experts engaged in much more analysis and evaluation than the novices throughout the problem-solving process. Novices provided little support for their solutions and often did not evaluate their solutions in terms of all critical constraints. The experts identified subproblems in the process of exploring the consequences of various possible solutions. For example, an expert problem solver considering increased agricultural use of capital equipment and petroleum-based fertilizers might realize that political support must be obtained from central planners for the steel and chemical industries. Novices simply did not engage in this kind of reflection; they generally identified possible solutions and quit.

KNOWLEDGE NEEDED FOR EXPERT PROBLEM SOLVING

Research on problem solving (Voss et al. 1983) illustrates some of the ways that expert and novice economic problem-solving performances differ and demonstrates the importance for education of understanding how experts' knowledge differs from that of novices. Certainly, experts have more concepts and information in their fields of expertise than novices. However, there is more to it than that. It is at this point that cognitive psychological research on knowledge utilization provides useful insights for economics teachers. This section considers six types of knowledge that experts use to solve problems. Economics teachers must consider the instructional implications of these kinds of knowledge if they hope to teach their students to use economics to think systematically about social phenomena.

Domain-Specific Knowledge

Domain-specific knowledge is the subject-matter knowledge in a field and is the kind of knowledge most people have in mind when they think about knowledge. However, domain-specific knowledge has more dimensions than the one or two usually discussed. As one would expect, expert economic problem solvers possess large stores of *declarative knowledge*, that is, "knowledge about" economics and social phenomena, in their long-term memories (Voss 1989). Declarative knowledge includes definitions of concepts, for example, marginal utility. It includes specific factual information, for example, Alan Greenspan is the current chairman of the Board of Governors of the Federal Reserve System. It also includes generalizations, for example, the Law of Demand. If one's declarative knowledge base is relevant to the problems one wishes to solve, it is a valuable resource for solving economic problems.

Another dimension of expert economic problem solvers' knowledge is *procedural knowledge*, that is, "knowledge of how to" (Voss 1989). Procedural knowledge requires declarative knowledge (concepts, facts, generalizations) and the ability to apply it to questions for which answers are not immediately obvious. If confronted with a productivity problem, an expert economic problem solver knows how to define, operationalize, and compute useful productivity indices. If confronted with a set of data on marginal costs in a production process, an expert problem solver can interpret the data and extract useful information about the problem at hand. Given a change in the Federal Reserve System discount rate, an expert can predict the probable effects on demand for goods and services in particular industries. Experts generally have extensive procedural knowledge in their areas of expertise; novices are likely to have little or none. Procedural knowledge is a qualitative difference in the domain-specific knowledge bases of experts and novices in a particular area, such as economics. It helps explain important differences between experts' and novices' efforts to solve problems.

Schematic knowledge is another critical dimension of economic problem solvers' domain-specific knowledge. People tend to organize their knowledge in terms of schemata, that is, networks of ideas (Cornbleth 1985; Glaser 1984). For example, consider an economic expert's knowledge related to productivity. Investment in productive resources (e.g., capital goods) can lead to increases in productivity. Increases in productivity can lead to higher rates of return on resources invested and stimulate additional investment. Schemata can be represented graphically; common economic examples are supply and demand graphs and diagrams of the circular flow of economic activity. Experts have more schemata than novices, and experts' schemata are developed more fully in their areas of expertise. As a result, expert problem solvers represent problems more adequately than novices do.

Domain-specific schemata provide useful ways of conceptualizing problems, and they enable expert problem solvers to perceive what knowledge is needed to solve a problem and to access information they already possess in their long-term memories. Simon (1980) described this function of schemata in terms of indexing and cross-referencing a knowledge base held in long-term memory. Consider again the productivity schema. An expert has knowledge indexed in terms of investment in capital goods. For example, an economic expert would remember definitions, examples, particular cases of capital investment and their results, various constraints on capital investment, political controversies involving capital investment, and much more. Even more important for problem solving, an economic expert's knowledge of investment in capital goods would be cross-referenced with other knowledge. For example, an expert would also probably think of investment in research and development and its relationship to capital investment. He or she might also note the interdependence between the quality of human resources and the effective use of particular kinds of capital. Further, the expert might address the impact of government economic intervention in the form of tax rates and credits on rates of return that affect the value and probability of capital investment.

A novice's list of economic concepts related to productivity would not be nearly as helpful in thinking about productivity problems as an economic expert's schema. Voss et al. (1983) observed that novices often did not use all the relevant knowledge that they possessed. The lack of adequate schemata is one of the reasons their knowledge was not activated. Domain-specific schemata are critical for effective problem solving in economics or any other domain.

Metacognitive Knowledge

Another cognitive difference between experts and novices is their *metacognitive knowledge.* Metacognition refers to several phenomena: (1) knowledge of what one knows about particular subjects and when and how to use that knowledge; (2) declarative and procedural knowledge of general strategies for thinking about problems, the so-called weak methods; and (3) knowledge of how to manage one's thinking, sometimes called cognitive self-management (Nickerson 1988). These general ways of thinking are less domain-specific than the kinds of knowledge discussed earlier and are potentially applicable in a wider variety of problem-solving contexts.

The first dimension of metacognitive knowledge focuses on the problem solver's awareness of what he or she knows about a subject and the relevance and applicability of that knowledge for understanding phenomena and solving problems. This is sometimes called *conditionalized knowledge* (Bransford, Franks, Vye, and Sherwood 1986). For example, when one hears the quarterly sales and earnings reports of General Motors, Ford, and Chrysler, does the investment-productivity schema come to mind to help explain the relative performances of these corporations? If the local Little League fund-raising barbecue consistently does not generate enough income, is the problem articulated as a problem of insufficient productivity? If a problem solver knows that the investment-productivity schema, among others, is relevant to understanding these phenomena, then he or she possesses conditionalized knowledge about investment and productivity. A common error of economics teachers is to underestimate how difficult it is for students initially to perceive linkages between declarative knowledge and situations in which that knowledge can be applied. Unless one's knowledge of economics is conditionalized, it is unlikely to be used even if it is remembered.

The second dimension of metacognitive knowledge includes knowledge of general ways to think about problems and to attempt to solve them. Such general problem-solving strategies are often called *weak methods*, in contrast to *strong* domain-specific procedural knowledge, such as cost-benefit analysis (Nickerson 1988). General cognitive strategies are weak in the sense that they do not depend on much domain-specific knowledge and do not lead to solutions with as much certainty as more domain-specific procedures often do. However, general cognitive strategies are applicable in a wide variety of problem-solving contexts across subject domains.

Newell (1980) identified a variety of general problem-solving strategies: generate and test, climb hill, search with heuristics, analyze means-ends, match, hypothesize and match, and satisfy constraints. In the Voss et al. study (1983), *decompose* was a frequently used strategy; most subjects divided the Soviet agriculture problem into several subproblems and worked on them separately. Nickerson (1985) identified more strategies: work backwards, test extreme cases, and set goal. Both experts and novices use general problem-solving strategies, but their choices and ways of using them vary.

The third dimension of metacognitive knowledge is *cognitive self-management strategies.* In the context of the Soviet agriculture problem (Voss et al. 1983), expert problem solvers demonstrated their abilities to manage their thinking in several ways. First, after stating the problem, they did not immediately begin to generate solutions. Instead, they considered the context of the problem, historically or politically, and assessed various dimensions of the problem. Second, they evaluated their tentative solutions in terms of feasibility and probable effectiveness. Third, experts identified new subproblems or converted constraints to subproblems during the process of evaluating tentative solutions; that process led to revision of their problem representations and to other solutions. These problem-solving strategies are not domain-specific; they could be used in solving any problem. They indicate the ability to manage one's own thinking (Bransford, Vye, Adams, and Perfetto 1989).

Unfortunately, general problem-solving and cognitive self-management strategies are not often taught, not necessarily learned if taught, and not transferred from the initial learning context if learned. Voss et al. (1983) also posed the Soviet agriculture problem for political scientists and economists not specializing in the Soviet Union and for university chemists. Although these highly trained problem solvers tended to be more analytical than the novices, their reasoning processes were more like those of the novices than those of the Soviet specialists. This finding underscores the difficulty of transferring metacognitive skills from one subject matter domain to another. Students must be guided explicitly in applying and adapting these general cognitive skills in economics if more than a few are to succeed (Perkins and Salomon 1989).

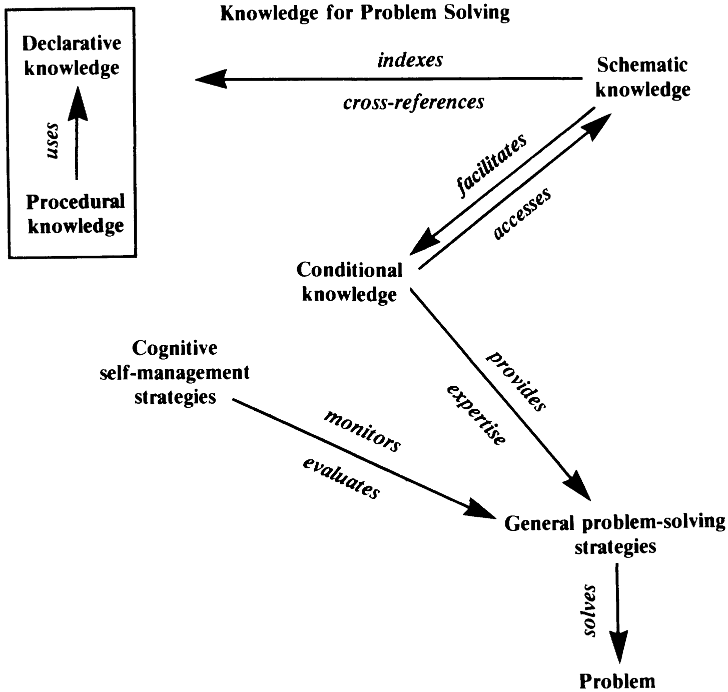
To summarize, domain-specific knowledge is composed of declarative and procedural knowledge. Aspects of this knowledge are organized as schemata (networks of ideas). The components of the schemata are index entries for more information stored in long-term memory. Relationships within the schemata cross-reference knowledge in memory. Conditionalized knowledge, one aspect of metacognitive knowledge, enables one to access and apply domain-specific knowledge and problem-solving procedures (strong methods) in the context of problematic situations. General problem-solving strategies, another aspect of metacognitive knowledge, enable problem solvers to structure problem-solving efforts and to identify tasks that domain-specific knowledge can help to accomplish. Cognitive self-management strategies, the third aspect of metacognitive knowledge, enable problem solvers to monitor and evaluate the quality of their problem-solving efforts and to refocus those efforts when necessary. Figure 1 schematically represents problem-solving knowledge. If these kinds of knowledge are available to problem solvers, then their problem representations and solutions are likely to be effective.

PROBLEM-SOLVING INSTRUCTION CRITERIA

Criteria for developing and evaluating instructional programs designed to teach economic problem-solving skills can be derived from the discussion of the types of knowledge needed for effective problem solving. An effective instructional problem-solving program should teach domain-specific knowledge and procedures in the context of solving problems. Evidence exists that knowledge acquired in the process of attempting to solve domain-specific problems is stored in long-term memory more effectively and is more accessible than knowledge acquired apart from problem-solving activities (Bransford, Franks, Vye, and Sherwood 1986). In addition to the basic knowledge of economic concepts and principles, students should be taught explicitly to develop schemata to organize their knowledge coherently to promote retention and to make that knowledge more accessible for problem solving through the cross-referencing function of schemata (Bransford, Sherwood, Vye, and Rieser 1986). Using knowledge to solve problems requires articulation of connections between various aspects of one's knowledge base and highlights the relevance of particular knowledge to important types of problems in a field.

Metacognitive knowledge and skills should be taught in the context of domain-specific instruction. Students should be told and shown explicitly how economic ideas are related and when and how they can be used to solve economic problems (Bransford, Vye, Adams, and Perfetto 1989). A critical aspect of conditionalized knowledge is the ability to perceive and categorize

FIGURE 1
Knowledge for Problem Solving



a problematic situation as a particular type of problem, for example, a productivity problem (Bransford, Franks, Vye, and Sherwood 1986). Such conditionalized knowledge is acquired through experience in solving problems; however, explicit instruction facilitates the process. Economics teachers should provide students with opportunities to practice classifying problems and identifying economic knowledge relevant to their solution.

General problem-solving strategies can be fitted to domain-specific contexts. Problem solvers, including students, probably have preferred general strategies. Students will benefit by considering alternative strategies for different types of problems. For example, the general cognitive strategy advocated by the JCEE (Saunders et al. 1984) is the *satisfy-constraints* strategy, which is particularly useful when making a choice among a set of alternative actions to solve a problem. In this model, proposed actions to solve a problem are evaluated in terms of a set of constraints (i.e., criteria, goals, values); the alternative that best satisfies the constraints is chosen as the solution to the problem. However, the satisfy-constraints strategy is less useful for answering a question about the nature of the empirical world than the *generate-and-test* strategy. A problem solver using the generate-and-test strategy develops hypotheses that might answer a question about the nature of the empirical world, collects data, and tests the hypotheses with the data.

Students also should be taught to incorporate domain-specific knowledge and procedures into the general strategies (Perkins and Salomon 1989). For example, it is helpful to decompose the Soviet agriculture problem into political and productivity subproblems, an application of a general problem-solving strategy. However, if one does not perceive the relevance to the problem of one's knowledge and skills regarding productivity, problem solving is impeded seriously. Cognitive self-management skills should be taught explicitly. For example, students should be taught the benefits of exploring a problem's historical and contemporary social contexts and representing the problem in different ways (e.g., economic, political, technological) before formulating solutions.

Problem-solving performance responsibilities should be transferred systematically from the teacher to the students. One approach to this task is to provide students with practice using knowledge and procedures in a variety of contexts (Bransford, Vye, Adams, and Perfetto 1989). For example, productivity problems can be addressed in terms of personal problems, informal group decisions, business settings, and societal issues. A second approach is cognitive apprenticeship (Collins, Brown, and Newman forthcoming; Nickerson 1988). Cognitive apprenticeship requires modeling skillful problem solving, coaching students as they attempt to solve problems using domain-specific and metacognitive knowledge, and decreasing the level of teacher guidance so that students have increasing responsibility for their problem-solving performances. To teach students to reason with economics, economics teachers must become articulate about how they think as well as the subject matter they use in thinking.

CONCLUSION

Economic reasoning is a major curricular goal in introductory courses in economics as well as in more advanced courses. Much recent research on problem solving is relevant to educators who wish to teach their students to reason with economic concepts and principles. Given the findings from cognitive psychological research on problem solving, economics teachers and instructional designers should implement the following guidelines:

- Teach economic content in the context of problem-solving tasks.
- Teach students to construct or acquire schemata that coherently link economic concepts and principles with each other and with economic problems.
- Teach students to recognize the relevance and use of economic ideas in solving particular kinds of economic problems.
- Explicitly teach general problem-solving strategies to guide students' problem solving and to facilitate their application of economic knowledge.
- Teach students to use general problem-solving strategies in conjunction with specific economic ideas.
- Provide students with opportunities to use the general strategies and

economic knowledge in a variety of settings (e.g., personal, business, school, community).

• Systematically transfer responsibility for problem-solving performance from teachers to students through a sequence of modeling, coaching, and fading.

These conditions will enhance the instructional effectiveness of programs designed to teach students to solve economic problems in their roles as citizens, learners, and private individuals.

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