Teaching Reasoning and Decision-Making in Introductory Cognitive Science Courses

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Abstract

The subjects of reasoning and decision-making provide a means of exploring a number of issues central to the interdisciplinary field of cognitive science. Among these are: formal systems, rational versus intuitive thinking, content and context effects on cognition, individual differences and cognitive styles, the nature of intelligence, modularity of cognitive functions, and educational impacts on cognition, to name a few. Different methods of inquiry and analysis can also be conveniently demonstrated within these subjects. I present some suggested topics, readings, and activities for use in teaching these subjects.

Introduction

One of the challenges in teaching cognitive science at the introductory level is to convey the fundamental interdisciplinarity of the field. What has always drawn me to the field is the fact that it is constituted by such different kinds of researchers—psychologists, computer scientists, philosophers, linguists, neuroscientists, anthropologists are some that come immediately to mind—bringing their own disciplinary frameworks and methods of inquiry to bear on questions and topics that cut across several disciplines.
Reasoning and decision-making are two such topics. Both are considered to be complex, higher-order, cognitive tasks. Both are considered to be hallmarks of intelligent behavior. Both have been studied by researchers in a variety of the fields listed above.

I teach these subjects in a variety of cognitive science courses. I cover them in a lecture or two of the introductory cognitive science course, as well as in a mid-level course in cognitive psychology. I’ve also developed a mid-level course entitled Thinking, Reasoning, and Decision-Making, that treats both subjects in much greater depth, i.e., several lectures each. In the next year or two, I will be developing an introductory freshman seminar in cognitive science entitled, Rational Thinking, Intuitive Thinking. In this essay, I’ll focus on resources for one or two lectures on these subjects, at the introductory level. However, syllabi for all of these courses (except the to-be-developed freshman seminar) are available on my website at the following url: http://apps.carleton.edu/people/kgalotti/teaching/.

I begin with definitions and distinctions among similar terms. I use the term thinking as a more general term encompassing reasoning and decision-making (Galotti, 1989). Thinking has been variously defined as “going beyond the information given” (Bruner, 1957); filling gaps left by incomplete information (Bartlett, 1958); a means to resolving a state of doubt (Dewey, 1933); or searching through a problem-space (Newell & Simon, 1972). In addition to reasoning and decision-making, the term thinking is meant to include a variety of other higher-order cognitive processes, such as daydreaming, brainstorming, goal-setting, and planning.

The term reasoning covers either thinking that uses a well-defined system of logic, such as propositional logic, and/or thinking on a small set of very well-defined tasks. These tasks include such things as categorical, conditional, or linear syllogisms, verbal or geometric analogy problems, or series completion problems (Galotti, 1989). At its heart, reasoning involves drawing a conclusion based on some given information and in accordance with certain boundary conditions specified by the task.

The term decision-making refers to an assessment of, and choice from among, alternatives in terms of their probability of occurrence and their expected value. This assessment and consideration may be explicit and complex or implicit and rapid, but without consideration of alternatives, no decision-making can be said to have taken place (Galotti, 2002).

An Opening Exercise

I use the following exercise as a first-day class opener in my mid-level Thinking, Reasoning, and Decision-Making course, but it could easily be adapted for use in an introductory cognitive science course as well. It allows me to preview several of the themes mentioned above, it actively involves most students in discussion, and it serves as an initial ice-breaker for that awkward first day of classes.
Students are divided into small groups of five or six. In these small groups, they are asked to complete two reasoning/decision-making tasks. Specifically, they are instructed to first think about each task individually, making notes or diagrams if they wish, and to generate their own individual solution. Next, they are to divide the group in half. One half of the group will discuss their proposed solution to the task while the other half of the group observes and makes notes on what factor or factors seem to be making the task easy or difficult, and on whether different individuals seem to be adopting different approaches or styles to the task. On the second task, the two groups switch—the observers become the performers, and the performers become reasoners.

The first task comes from logician Raymond Smullyan (1982), in a delightful book of logical puzzles. Any one of the puzzles could be chosen; I happen to use the first four from Chapter 2. They are all variations on classic “knight/knave” puzzles, where knights always tell the truth, and knaves always lie, and the task is to figure out who is what. The task is almost certainly guaranteed to provoke lively debate and animated discussion. At least a handful of students (in a class of 30) will really love this kind of puzzle, and will tend to dominate the groups they are in. Another, larger group of students, will groan as they first read the handout, and will be relatively passive in their small groups. (But, they will have a lot to say later in the discussion about specifically why they dislike this kind of thinking, so the exercise is still valuable for them!)

The second task comes from the book, *Making Decisions* by Hill, Chechile, Crochetiere, Kellerman, Ounijian, Pauker, Pauker, and Rubin (1978). It represents more “everyday” reasoning. It is presented as a narrative of Connie Arnold and her husband Jim, who have received multiple letters (reproduced in the handout) from Connie’s elderly “dear Aunt Sarah.” Sarah is a widow with no children of her own who wants to come live with Connie and Jim and their two children. Information about the nature of Connie’s relationship with her aunt, her aunt’s health, personality, and financial circumstances are presented, and the case brings up various social and moral issues. Typically the students who loved the first task are more lukewarm toward this one, but the students who disliked the first task really sink their teeth into this one!

Next, the class is reconvened and we discuss differences in the two tasks—what adjectives come to mind about the tasks, how did students approach each of them, how did other students in their group describe them, what made each of the tasks easy, what made each of the tasks hard? I list responses at the board as students offer ideas. My intention is to have them describe and appreciate the distinction between formal and everyday reasoning (Galotti, 1989). Essentially, formal reasoning problems include the following aspects or features:

- All premises (given information) are supplied in the problem.
- Problems are self-contained.
- There is typically one correct answer.
- Established methods of inference that apply to the problem often exist.
- It is typically unambiguous when the problem is solved.
- The content of the problem is of limited, academic interest.
• Problems are often solved for their own sake. (Galotti, 1989, Table 1, p. 335)

In contrast, everyday reasoning problems have the following features:

• Some premises are implicit, and some are not supplied.
• Problems are not self-contained.
• There are typically several possible answers that vary in quality.
• There rarely exist established procedures for solving the problem.
• It is often unclear whether the current “best” solution is good enough.
• The content of the problem typically has potentially personal relevance.
• Problems are often solved as a means of achieving other goals. (Galotti, 1989, Table 1, p. 335)

Why draw the distinction between formal and everyday reasoning? In large part, my motivation is to begin a discussion of the question, how good are formal reasoning models at capturing essential aspects of everyday reasoning? Put differently, is the study of performance on formal reasoning tasks just an empty exercise? Or do the processes used to reason syllogistically, say, form the core of what it is to reason about the likely consequences of a gas tax holiday? Credible arguments can be made both ways, and students seem to really sink their teeth into the issue.

Further Fundamental Issues

After generating the lists, the discussion can go in any number of directions, depending on instructor goals and preferences. I’ll sketch a few possibilities here and give you some starting references.

Cognitive Processes Comprising Reasoning

Sternberg’s (1977) componential analysis of analogical reasoning is a classic. In fact, in my mid-level course, students actually conduct an audio-recorded session wherein a participant not taking the class is asked to reason aloud with geometric analogies (one possible source: Sternberg (1986)) and each student analyzes the protocol with respect to Sternberg’s list of component processes. See Ericsson and Oliver (1988) or Perkins (1981) for discussions on the pros/cons/how-tos of obtaining and analyzing on-line verbal protocols. This assignment should be easily adaptable to an in-class exercise.

Rationality of Thought

The degree to which formal models of logic provide a model of human performance is grist for the mill of a spirited discussion. Texts such as Baron (2008) or Halpern (2003) provide an overview of such topics as propositional reasoning, which was originally claimed to be the basis of human thought by the logician Boole (1854). (Whether or not an excursion into teaching propositional logic is warranted at the introductory level is up for debate—personally, I don’t get into these topics until students
take a mid-level course). Baron provides a nice tripartite description of psychological models: *descriptive*, a model that non-evaluatively delineates what people actually do when they reason or make decisions; *normative*, a model that specifies what people *ought* to do under ideal circumstances and unlimited time and knowledge; and *prescriptive*, models that offer a realistic benchmark against which people’s decisions can be evaluated, taking into consideration the constraints on their time, knowledge, energy, and other priorities.

**Cognitive Processes in Decision-Making**

I have offered a list of phases of decision-making, including setting goals, making plans, gathering information, structuring a decision, and making a final choice (Galotti, 2002). Figure 1 presents a conceptualization of how these processes interrelate. These phases are presented at a much more general level than Sternberg’s component processes, and an instructor could lead a discussion on levels of explanation, or could have students generate on-line protocols to assess the usefulness of this descriptive model of decision-making. Readings relevant to each of the phases of decision-making can be found in the chapters of my 2002 book, should you want to focus on a specific phase in your lectures.

![Figure 1: Phases of Decision-Making (Galotti, 2002, p. 97)](image-url)
Individual Differences in Reasoning and Decision-Making

Students enjoy consideration of the topic of whether there exist difference styles of decision-making and if so, what their own style might be. Readings on cognitive styles generally, and decision-making styles specifically, include Sternberg and Grigorenko (1997) and Scott and Bruce (1995), respectively. My collaborators and I describe some research on individual differences in decision-making among college students selecting a major (Galotti, Ciner, Altenbaumer, Geerts, Rupp, and Woulfe, 2006).

Final Thoughts

As is probably evident, I’m a big fan of active participation in lectures concerning the topics of reasoning and decision-making, which otherwise can become quite technical and dry. It has always been important to me to consider formal models of reasoning and decision-making in the context of everyday analogs of these tasks, both in my teaching and in my research agenda (Galotti, 2007). In teaching, the connection of the formal to the everyday not only engages student attention and participation, but it also forces us to consider questions of how well our research bears on important topics in everyday life, an important and (in my opinion) vastly understudied topic.

Best of luck to all instructors of the critically important introductory cognitive science course. May your class sessions be substantive, vibrant, engaging, and professionally fulfilling!!

References


Boole, G. (1854). An investigation of the laws of thought, on which are founded the mathematical theories of logic and probabilities. London: Macmillan.


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