Symposium on Collaborative Knowledge

Paul Thagard
Philosophy Department, University of Waterloo
Waterloo, Ontario, Canada N2L 3G1
pthagard@watarts.uwaterloo.ca

Abstract

This symposium will discuss various kinds of collaborative knowledge, i.e. knowledge that develops as the result of the cooperative work of groups of people.

Introduction

In recent years, researchers in many fields have paid increasing attention to social aspects of the development of knowledge. In philosophy, *social epistemology* has begun to address numerous questions about how knowledge develops in social contexts. Psychologists and anthropologists are paying increasing attention to *distributed cognition*, examining knowledge not merely as the possession of individual minds, but as also dependent on social and physical environments. In computer science, there is growing interest in *distributed artificial intelligence*, which concerns how expertise can be investigated in networks of cooperating computers rather than in individual ones. Finally, sociologists have made strong claims about the social production of scientific knowledge.

One important social aspect of knowledge is that it is often produced and shared by groups of people. In the natural and social sciences, it has become much more the norm than the exception to have work produced by two or more cooperating scientists. Similarly, the success of many businesses and other organizations depends on knowledge shared among numerous individuals.

This symposium will present four lines of research concerned with collaborative knowledge. Kevin Dunbar and Paul Thagard will discuss scientific collaborations, while Gary Olson and Edwin Hutchins will describe research concerning other kinds of collaboration and communication.

Kevin Dunbar, Department of Psychology, McGill University

In Vivo Reasoning: How Groups of Scientists use Distributed Reasoning while Conducting their Research and Making Discoveries

How do scientists think, reason, and solve problems? Are distributed reasoning and problem solving important components of scientific inquiry? For the past few years I have been addressing these questions by investigating scientists conducting research in their own laboratories. I have collected data from four molecular biology laboratories over a one year period. This data includes weekly group laboratory meetings, interviews, drafts of papers and grant proposals. Using this approach it has been possible to build a comprehensive account of the cognitive and social processes that are involved in reasoning, problem solving and the generation of scientific discoveries. In particular, this data has allowed us to formulate a model of how cognitive and social mechanisms provide mutual constraints on the types of theories scientists propose and the experiments that they conduct.

In this talk, I will focus on one aspect of our findings; that one of the most successful strategies that scientists use is group problem solving. Group problem solving consists of individual scientists performing basic cognitive operations such as induction and then passing this information on to other scientists in the group. The results of one individual's cognitive operations thus serve as the input to another individual's cognitive operations. The results of these cognitive operations are then used to build a new cognitive representation. How and when the information is passed between individuals depends on the goals of the individuals and the group, as well as the knowledge bases that the scientists in the group have at their disposal. I will focus on how new concepts in immunology and HIV were constructed by the process of group problem solving. I will propose a model of how cognitive and social mechanisms mutually constrain each other and describe what happens when principles of the model are violated. Finally, I will argue that group problem solving heuristics make it possible to circumvent many of the limitations in reasoning that individuals have.

Edwin Hutchins and Brian Hazlehurst, Department of Cognitive Science, University of California, San Diego

A Model of the Emergence of Shared Communicative Resources

The use of shared language is one of the central facts of human existence. Language appears to be closely tied to most high level cognitive activities. It mediates most of the social interactions among members of the most social of all species. Once a language exists, it is not difficult to think of the means by which it could be maintained and propagated from generation to generation in a population. But without anyone to tell individuals which language to speak, how could a language ever arise? This paper presents a family of simulation models that explore the emergence of shared communicative resources from the interactions of simple cognitive agents in an artificial world. The problem of creating shared structure is solved by having cognitive agents that are capable of learning to classify a world of phenomena share expressions of experience in interactions with one another. The models are instantiations of a theory of cognition that takes symbol systems to be products of both inter- and intra-individual processes.

Gary M. Olson, Psychology Department, University of Michigan

Collaborative Problem Solving as Distributed Cognition

We have been studying small groups in both the field and the laboratory as they do collaborative design tasks. This is a representative setting for cognitive activity in work settings. An examination of these situations reveals very clearly how an adequate description of cognitive activity needs to include both the social and the physical settings. Moreover, in doing so one's view of cognitive activity is altered in profound ways. The resources and constraints that affect cognitive activity have a very different profile than those associated with traditional models of individual cognition. I will present an early picture of what these factors are, and will illustrate them with examples from our research.

Paul Thagard, Philosophy Department, University of Waterloo

Collaborative Knowledge in Science,

In April 1994, a group of 450 physicists centered at Fermilab presented evidence for the existence of the top quark, an important theoretical construct of the Standard Model of particles and forces. Although the size of this group is unusual, the collaborative nature of their work is not. The dramatic growth in publications with multiple authors shows that collaboration has become increasingly common in the social as well as the physical sciences. This talk will examine collaborative knowledge from both descriptive and prescriptive viewpoints. How prevalent is collaborative knowledge? Why do scientists collaborate? What kinds of collaboration are most productive? How can collaboration be made more productive? What does collaboration tell us about the nature of knowledge?

After briefly reviewing the extent and nature of collaborative work in the sciences, I shall discuss four different kinds of scientific collaboration from the perspective of the five epistemic standards that Alvin Goldman has proposed for evaluating social epistemic practices. Collaborations can be classified as employer/employee, teacher/apprentice, equal-and-similar, and equal-but-different. The last kind of collaboration, involving researchers with very different knowledge and skills, is particularly important in an interdisciplinary field like cognitive science. The benefits and costs of different kinds of collaboration can be assessed in terms of the standards of reliability, power, fecundity, speed, and efficiency.

References

Dunbar, K. (in press). How scientists really reason: Scientific reasoning in real-world laboratories. In R. J. Sternberg & J. Davidson (Eds.), *Mechanisms of insight*. Cambridge, MA: MIT Press.

Hutchins, E. (1990). The technology of team navigation. In J. Galegher, R. E. Kraut, & C. Egido (Ed.), *Intellectual teamwork: Social and technological foundations of cooperative work* (pp. 191-220). Hillsdale, NJ: Lawrence Erlbaum Associates.

Olson, G.M., Olson, J.S., Carter, M., & Storrsten, M. (1992) Small group design meetings: An analysis of collaboration. *Human-Computer Interaction*, 7, 347-374.

Olson, J.S., Olson, G.M., Storrsten, M., & Carter, M. (1993) Groupwork close up: A comparison of the group design process with and without a simple group editor. *ACM Transactions on Information Systems*, 11, 321-348.

Thagard, P. (1993). Societies of minds: Science as distributed computing. *Studies in History and Philosophy of Science*, *24*, 49-67.

Thagard, P. (in press). Mind, society, and the growth of knowledge. *Philosophy of Science*.