To be published in the journal of *China Education Technology*

Group Cognition as a New Science of Learning:

An Interview with Gerry Stahl

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Computer-Supported Collaborative Learning (CSCL) is a major emerging branch of the learning sciences. It is concerned with studying how people can learn together with the help of computers. **Gerry Stahl** is a researcher and tenured professor of information science at Drexel University and founding editor of the International *Journal of Computer-Supported Collaborative Learning* published by Springer. He has been active in the International Society of the Learning Sciences (ISLS) since it's start in 2002. He served as Program Chair for the CSCL'02 international conference and workshops chair for CSCL '03, '05, '07 and '09. He earned his B.S. in humanities & science from MIT in 1967 and received his M.A. and Ph.D. in philosophy at Northwestern University in 1975. Later he achieved M.Sc. and Ph.D. degrees in computer science at the University of Colorado in 1993. From 1996 to 2001 he was a postdoctoral research fellow and a research professor at the University of Colorado. His research focuses on collaborative knowledge building in computer-supported learning environments and on the practices of collaborative small groups of students. In the past decade, he and his research team have explored his theory of "group cognition" and developed software to support collaborative problem solving of school mathematics. His theory of group cognition and his book, *Group Cognition: Computer Support for Building Collaborative Knowledge*, has had an important influence on CSCL and the learning sciences. He has published almost 200 journal articles, book chapters and conference papers.

1. Professor Stahl, you have been a leading proponent of CSCL during the past decade and also an active researcher in the learning sciences. The chapter in the

Cambridge Handbook of the Learning Sciences *by you with Koschmann and Suthers has introduced CSCL and given a general picture of how CSCL developed and what it is mainly about. In that chapter, you proposed that computer applications in education or instructional technologies have undergone a sequence of approaches, and that CSCL represents the most recent stage in that progression. My question is: What is the striking difference between CSCL and the previous approaches? Does that mean CSCL represents a new paradigm of instructional technology?*

First, let me emphasize that CSCL is a diverse field with researchers working in a variety of different ways. Some CSCL researchers come from education, psychology, computer science or social science; some are more interested in computer software design, in research methodology, in psychological models or in classroom practices. Hopefully, all these approaches fit together and complement each other, although there are some tensions and apparent incompatibilities, as in any active interdisciplinary field. Koschmann, Suthers and I have similar backgrounds, interests and research agendas, so we co-authored an introduction to CSCL that reflected our common orientation. We are particularly interested in detailed analysis of discourse in small groups of learners, and in developing a theory of what Koschmann calls "practices of understanding," Suthers calls "intersubjective meaning making," and I call "group cognition." Our chapter (Stahl, Koschmann, & Suthers, 2006)—which is available in Chinese and other languages—reports on the history of CSCL, important research projects and books in the field, software design issues, alternative research methodologies and theories.

We argue that what is important and new in CSCL is the focus on collaborative groups of learners. Previous instructional software, educational research and pedagogical theory looked almost exclusively at individual learners. CSCL looks at how learning takes place in small groups working together, thanks to networked computers, computer support for learning and computer simulations. Whereas previous instructional software was designed for individual users, CSCL software is multi-user, supporting communication, coordination and collaboration. Whereas previous educational research tried to get at individual knowledge and mental models through individual testing, surveys and interviews, CSCL tries to study the group interactions that build collaborative learning. This makes for a huge paradigm shift. While we believe that learning has always been a fundamentally social, interpersonal process, the availability of networked computers (and mobile devices) creates new opportunities for supporting and for studying collaborative learning.

2. As a branch of the learning sciences, CSCL is concerned with the themes of cognition, social context and design. Can you explain where CSCL locates learning? What is the nature of collaborative learning? What role does social context play in CSCL? And what is the purpose and goal of design in CSCL?

These are large research questions without easy answers. The CSCL research field itself is an attempt at collaborative learning on a global scale to understand these issues better—and to redefine the questions and answers as part of a gradual paradigm

shift within education as it is practiced in schools and universities. The term "learning" itself carries traditional connotations of an increase in factual knowledge by an individual. So in CSCL, we often talk about "collaborative knowledge building" rather than learning, in order to avoid the connotations of traditional views so we can re-think the basic concepts of our field. Our goal in a CSCL classroom might be to have groups of students develop knowledge artifacts like documents expressing a theory, where the document gradually becomes more and more developed. The nature of collaborative learning is such that a group working together is likely to develop a document that takes into account more issues, uses more abstract conceptualizations and develops more sophisticated arguments than any individual member would have produced on their own. Through participating in the group process, the individuals may not only learn the theory that the group developed, but also learn to think about the theory from multiple perspectives as well as learning how to work well together with others on this kind of learning task.

The "social context" that you refer to is not just some kind of external factor influencing individual learning, but it is the group process itself, created in the interaction of the group and making the learning at every level possible. When a software designer understands collaborative learning this way, the goal of design is to support productive collaborative knowledge building. This certainly includes providing media for communication within the group across networked computers. But it also involves supporting group processes, like argumentation, seeking information, explaining terms, pointing things out. In addition, it may include making the created knowledge documents easy to modify, persistent for later use and sharable within a larger community.

3. In the past decade you and your research team have been studying collaborative knowledge building at the group level and published a lot of findings. One of the main achievements is that you proposed the theory of group cognition, which looks at a group as engaged in cognitive activities. This seems a very radical shift from the traditional learning view. What is the difference between group learning and individual learning? You argue that group cognition should serve as a foundation of a new science of learning, providing a coherent approach to computer support of collaborative learning in a global society. What is the core idea of your theory of group cognition? What is its implication for CSCL research and the learning sciences?

I developed the notion of "group cognition" while I was assembling selected writings from 1993-2002 into my book, *Group Cognition: Computer Support for Building Collaborative Knowledge* (Stahl, 2006). I realized that this was a hard concept to understand, and I wrote a couple of new chapters for the book to address this, as well as writing several papers on it later. My research from 2002 to the present has been on the Virtual Math Teams (VMT) project, with a wonderful group of collaborators. Highlights of this research are now available in *Studying Virtual Math Teams* (Stahl, 2009). Here, we try to study how small groups of students discuss math issues in an

online environment.

By looking closely at their discussions, we can see many interesting group processes taking place: the groups propose strategies for approaching a math problem, they construct diagrams, they divide problems into sub-problems, they point out patterns, they define new terms, they develop algebraic formulae, they engage in argumentation, etc. These are cognitive processes. We often attribute these activities to individual students, but here we can see them being conducted by small groups of students. The activities are not simple expressions of mental representations that were originally in the head of one student; we can see how they emerge from the interactions of the students and build on resources that exist in the context of the on-going discourse. Rather than seeing the origin of the shared ideas in the head of one student, we see it arising from the group—and possibly then being taken up by the individuals in the group within their individual learning.

Most of the theories important in CSCL stress the social nature of learning. Vygotsky (1930/1978) argues that all higher cognitive abilities of people develop first through interpersonal interactions. Lave & Wenger (1991) show how learning is often situated in communities of practice. In the VMT project, we know nothing about the individual students and their cognitive processes, but we can see how a group of three or four students can engage in a variety of group cognitive processes while discussing math in an online environment. We have developed research methods for analyzing the computer logs of their discourse. Our approach is inspired by ethnomethodology and conversation analysis, which focus on interpersonal interaction (Koschmann, Stahl, & Zemel, 2007). This is an approach that contrasts with methods from education and psychology, which focus on individual minds.

So when I write about "group cognition" I am writing about ways in which small groups accomplish cognitive tasks, like solving math problems and the sub-tasks involved in doing that like considering alternative proposals. I would not say that "groups think" or "groups learn" because that conjures up images based on our traditional conceptions of learning and thinking. But I would say that small groups can consider shared problems and can build joint knowledge. In fact, I would say that involving students in group cognition experiences can be a powerful way to teach them. To understand the power of collaborative learning or group cognition and to see how it can provide a foundation for individual intellectual development, the learning sciences must take CSCL seriously.

4. As we know traditional learning theory is mainly based on psychology, and it tries to explore what happen in individual minds in the learning process. It usually employs an experimental paradigm to examine whether one variable in the learning context is more effective or not with the comparison of pre-test and post-test. However in collaborative learning, you argue that small groups are the most fruitful unit of study and it is in principle easier to study learning in groups than in individuals. Can you explain your view? How should we analyze group learning or group cognition?

Yes. In situations of collaborative learning, the interactions are far too complex and uncontrollable to isolate simple linear causal variables or to test for learning when the participants are no longer involved in the collaborative setting. What a student is likely to do in a collaborative situation is radically different from what they might do in a controlled laboratory or an isolated test situation or an interview with a researcher. Direct access to individual cognition and learning is impossible, and indirect access is difficult and necessarily relies on questionable hypotheses and theories. In contrast, group cognitive processes are observable and can be captured rather rigorously in logs of computer-mediated interaction. The reason these group processes are observable is that the students in a group must make things visible for the other group members in order for the group to make progress together. Things must be visibly shared in the group. In a computer-supported group, making something visible means displaying it in the computer interface, and this can be captured in a computer log and played back by researchers. Assuming that the researchers understand the language of the students—including their mathematical moves—the researchers can observe the group processes that take place in the group discussion of the mathematics (although understanding what is going on often requires training, experience and hard work).

5. Just like the learning sciences generally, CSCL is an interdisciplinary field of research, including education, cognitive science, sociology, computer science anthropology and so on. This poses a challenge for a CSCL researcher to conduct deep and broad research. From your education background, we know you have studied philosophy, mathematics, cognitive science and computer science. With this rich interdisciplinary background, how do you integrate the various knowledge domains into your CSCL research? Do your have a holistic or coherent theoretical framework in your mind when you conduct your research? What theory and knowledge should researchers have when they conduct interdisciplinary research in CSCL?

It no doubt helps to have an interdisciplinary background, as many CSCL researchers do. The issues in CSCL are intertwined, requiring some perspective on software design, pedagogy, psychology and social theory. One also needs some understanding of the particular learning domain, such as mathematics. In addition, I have had to study ethnomethodology and conversation analysis as well as recent theories relevant to CSCL—activity theory, situated action, actor-network theory, distributed cognition. My students have had to pick some of this up on the side in order to follow our work in the VMT project. This is certainly a challenge. I am sure that it is even more of a challenge for people who—like the four Ph.D. students in the VMT project— are not from the USA or Western Europe and have not been exposed to many of these new theories.

There is no easy answer to how to prepare for conducting CSCL research, other than becoming associated with an existing CSCL lab. In my writings, I have tried to provide pointers to readings and ideas that I consider important and helpful. However, the field is constantly changing and one must gather together resources that one finds

helpful to what one is trying to accomplish.

I do not see theory as a pre-defined guide to research. For me, theory has to emerge from the research. It has to be grounded in analysis of real data from collaborative learning sessions. Otherwise, it will not be interesting theory, but will be some version of commonsense conceptualizations and preconceptions. If we have learned anything in the twentieth century it is that reality is quite different from what we imagine it to be like. When you look carefully at the log of a chat among several young students discussing math in a collaborative way, what you see is very different from the rational propositions that you might imagine. The postings are elliptical fragments, whose meaning depends almost entirely on references to previous text postings or to drawings done in the group. As you become familiar with this kind of data, you realize that it is actually much more sophisticated, complex and interesting than anything you might have imagined based on your previous theories.

Just as the students in a VMT chat rely on the many resources that are available to them at any given moment in their discourse, I do not base my work on some fixed theory but try to take advantage of whatever resources I may be familiar with to respond to my current task. This may be a dialog from Plato that I read in college or a new paper that I heard about and now need to download and read. Working in CSCL involves collaborating with a broad research community through papers, conferences and various joint activities or ways of sharing ideas.

6. CSCL is also a design science and it has both analytic and design components. The goal for design in CSCL is to create artifacts, activities and environments that enhance the practice of group meaning making. To address this issue, explore the group learning practice and establish new theory, researchers began to adopt designed-based research (DBR) in the learning sciences (Barab, 2006). It is used to study learning in real environments, which are designed and systematically changed as part of the research. The goal of DBR is to use the close study of an educational environment as it passes through multiple iterations within a naturalistic context, and to develop new theories, artifacts and practices that can be generalized to other schools and classroom. In one of your journal papers, you mentioned that you adopted this kind of design-based research process. How do you interpret this method? How do you employ this method? How do you bridge practice and theory? In China this method has been introduced, but there is no research practice reported yet. Can you give us some advice on how to use this method to carry out the relevant research?

The VMT project is an example of designing the software, conducting educational sessions, analyzing the data and developing theory as an integrated process. We have now gone through about five years of iterations. We started with a very simple commercial chat system and have expanded it little by little in response to the needs we observed in its usage by groups of students. We now have a very complicated system with a lobby for social networking, text chat, shared whiteboard, wiki, multiple tabs, social awareness, math symbolism, history reviews and explicit referencing. Integration of the different components is important in a complicated

interface. In our data analysis, we look at how the student groups themselves coordinate and integrate the different media in which they interact and how they take advantage of the various forms of persistence afforded by the different media. From the analysis, we develop theoretical conceptualizations, such as concepts of deictic referencing, persistence of media, coordination of work across media. These concepts, grounded in actual usage data, improve our theoretical understanding of how group cognition works and feeds back into design changes.

The DBR process can work organically without our having to think about how design, usage, analysis and theory are integrated. The main thing is that we start simply, with a minimum of preconceptions about what the software, pedagogy, analysis and theory should look like. We work as a collaborative team, sharing our observations and insights. And we iterate: re-designing the software, revising the kinds of math problems, digging deeper into the data with increasing understanding and writing theoretical papers—over and over again.

7. The conference on CSCL is an internationally recognized forum for the exchange of ideas related to learning through collaborative activity in technology-based learning environment. It is also one of the major conferences sponsored by the International Society of the Learning Science (ISLS). The CSCL conference has been held every two years since 1995, with the International Conference of the Learning Science (ICLS) in the intervening years. The theme of CSCL 2009 in Greece is "CSCL Practice." What does this mean for CSCL? What do you think will be the main research theme of CSCL and the learning sciences in the next ten years?

The organizers of CSCL 2009, which will take place in June 2009, wanted to highlight the practice of CSCL in the classroom. They are interested in seeing what ideas from the field of CSCL are ready to be used now in school classrooms, in colleges, in informal life-long learning and in workplace training. Some researchers feel this is premature; that the important systems and pedagogies for collaborative learning are yet to be developed and that the conference should concentrate on the needs of researchers, letting teachers go to other conferences to find out about commercial and open source applications. Other people interpreted the theme to mean the study of collaborative learning practices. My papers at the conference analyze the group cognitive practices that groups of students use in VMT.

The CSCL community is a global research community. CSCL 2005 was held in Taipei. The conference will return to Asia in 2011, with CSCL 2011 being held in Hong Kong or Singapore. The special theme then will likely have to do with educational policy at national levels.

The important themes in CSCL have remained quite consistent and are likely to continue into the next decade. CSCL is about how to best educate students for the world of the future. This will be a global world, making heavy use of networked computers and other digital devices, and requiring high levels of collaboration. So we have to understand how people work and learn together. This will guide us in

designing new forms of learning and new resources and technologies to support innovative pedagogies. The learning sciences has redefined our understanding of the learning process and we now see that rote learning is of limited value and collaborative learning is extraordinarily promising. Unfortunately, in almost every country, this new orientation has been systematically resisted and the nineteenth-century practices of drill and testing have been retained. If nothing new were learned in the learning sciences for the next ten years, there would still be plenty to do to bring what we already know to students around the world.

8. At CSCL 2002, Koschmann (2002) offered this definition for the CSCL domain in his keynote: "CSCL is a field of study centrally concerned with meaning and the practices of meaning making in the context of joint activity, and the ways in which these practices are mediated through designed artifacts." *Now, after seven years has passed, what do you think of this definition in terms of your research and CSCL community research themes? Is it necessary to redefine CSCL again?*

I loved that definition the first time I read it and I made it a focus of my introduction to the CSCL 2002 proceedings. I would still say that the phrase, "*the practices of meaning making in the context of joint activity*" is a good definition of what I mean when I say, "group cognition." The rest of the sentence, "*the ways in which these practices are mediated through designed artifacts*," completes the unity of DBR by relating the analysis of student practices to the design of the software that they use. The wording of the sentence uses the theoretical concepts that help us to understand the behavior or students in CSCL settings. It is about practices, meaning making, joint activity and mediation by technology. This is the post-cognitivist language that has replaced talk of facts being transferred from one form of memory to another. I do not think we need to redefine this as much as we need to understand it more deeply and put its implications into practice.

9. Can you introduce your research team's project? What is your main concern in your research? What is the goal of your research?

I have written a lot about this, most recently in *Studying Virtual Math Teams* (Stahl, 2009), which includes the most important papers by me and others involved in the project. The final chapter looks back over the project and its findings to argue that the VMT project can be taken as a tentative model for a new science of groups. I claim that the project was an example of design-based research that developed a software environment, a data corpus, a set of analyses, an appropriate analytic methodology and a theory of group cognition through an iterative process. This new science avoids using technology, methodology and theory that are oriented to individual minds and instead orients the whole activity toward the group as the unit of analysis. The findings from the project exemplify practices of group cognition.

Until recently, the goal of the project was to generate a rich data corpus for studying group cognition. It has now served that purpose for me, my colleagues, visiting

researchers and collaborators at other labs. We are currently trying to prepare it to be a practical online service at the Math Forum (http://mathforum.org) for people around the world to work on stimulating math problems together.

The ultimate goal of my research is to contribute in a small way to changing education in our world by helping researchers to understand the nature and potential of group cognition. Thank you, Shaoming, for asking such challenging and important questions and introducing my ideas in China.

Note: *Professor Stahl has made all his writings available on his website at http://GerryStahl.net. This site also includes many resources about CSCL. Pre-print versions of all articles in the* International Journal of CSCL *are freely available at http://ijCSCL.org. You can join ISLS and receive* ijCSCL *as well as access more information about CSCL and the learning sciences (including reduced registration for the conferences) at http://ISLS.org.*

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