Negotiation in Online, Synchronous, Collaborative Mathematics Problem Solving

The Virtual Math Teams (VMT) project is an NSF-funded research program through which researchers at the College of Information Science and Technology (IST) and the Math Forum investigate the innovative use of online collaborative environments to support effective K-12 mathematics learning.

An Opportunity

Visualize three participants living in different time zones, on different continents, drawn together by an interest in doing math. They are working on a math problem online. Each one of them

- understands the problem somewhat but cannot solve it alone ,
- has a different approach and wants the other two to help develop and use it,
- thinks the other two may know how to solve some aspect of the problem.

They need to negotiate with each other to frame the problem, figure out an approach from among their different perspectives, coordinate their activity and produce a solution which satisfactorily meets their collective expectations of a solution.

Problem Statement:

When problem solving is perfomed in a group setting, participants bring their individual perspectives. These perspectives may change in the course of their activity, as participants may present contrasting approaches, argue back and forth, adopt, transform or reject proposals and evaluate proposed solutions. Their effort seeks to arrive at some convergence through negotiation.

Negotiation, provisionally defined here as action to achieve mutual agreement, takes place in the constitution of a shared conception from multiple perspectives, as evidenced by the agreement which takes place, in many cases, after contentious debate. The interactional achievement constituted in how these individual perspectives converge into a collaborative solution is not sufficiently researched; even less research is devoted to the more recent, online, synchronous collaboration of the kind now made possible by the Internet.

Situating this research in mathematical problem solving, especially where a problem may have several possible answers or a single answer reachable through different approaches, makes it possible to examine a rich variety of interactions. We ask what the guiding mechanism of online, synchronous collaboration in mathematical problem solving is, to describe it and see if that guiding mechanism is negotiation.

Research Questions:

How is negotiation performed in online, synchronous, collaborative mathematics problem solving?

- How is collaborative participation negotiated?
- How is the shared problem negotiated?
- How is sustained joint attention and participation negotiated?
- How are situational resources enacted to support negotiation?

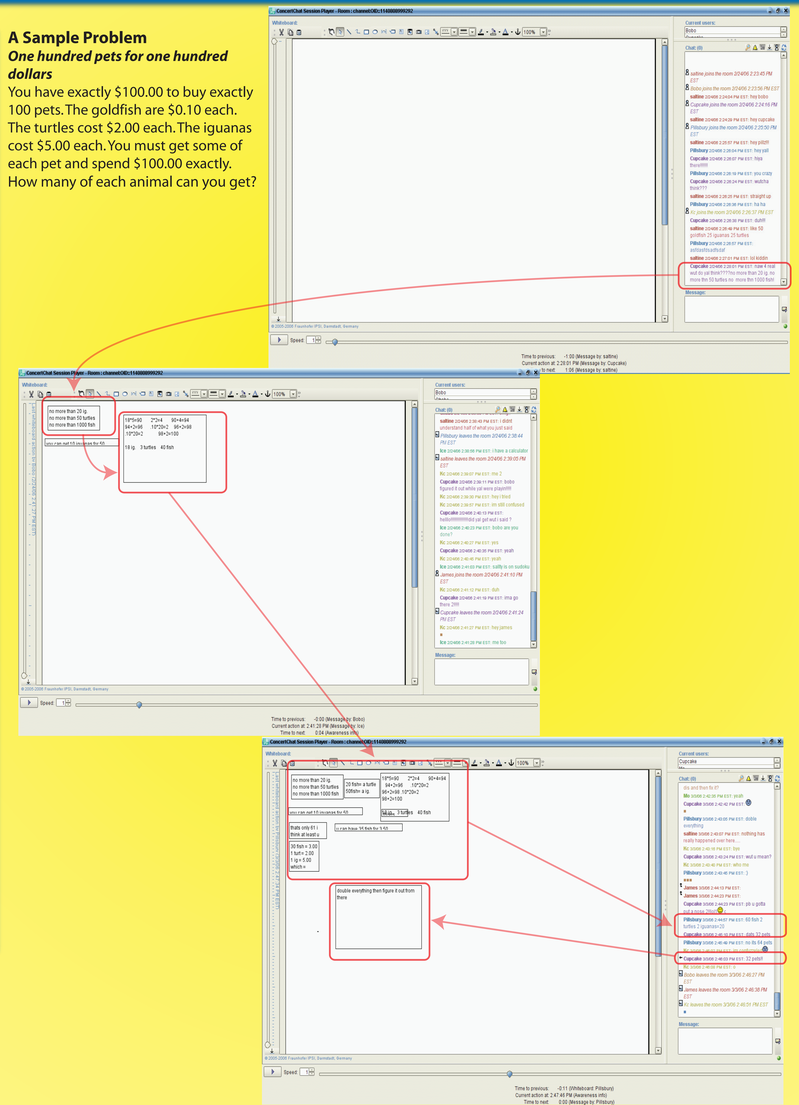
Theoretical Framework:

We use an ethnomethodological approach which consists in describing negotiation as it is constituted by those engaged in online synchronous collaborative mathematics problem solving. Design studies are also used, inasmuch as the affordances available in the computer support used in the problem-solving sessions, are changed throughout the course of the study, to better scaffold the problem solving being done by groups. We take the initial position that negotiation in an online synchronous mathematics problem solving is an interactional achievement, where there are identifiable member methods by which *the problem-solving group is constituted*, *the mathematical problem under consideration framed*, *the approaches to the solution and their order of implementation presented and assessed*, and *the solutions evaluated*.

A Sample Problem

One hundred pets for one hundred dollars

You have exactly $100.00 to buy exactly 100 pets. The goldfish are $0.10 each. The turtles cost $2.00 each. The iguanas cost $5.00 each. You must get some of each pet and spend $100.00 exactly. How many of each animal can you get?



We also hypothesize that the features of the available computer support contribute in the constitution of *the problem as the problem-being-solved*, of the constitution of *the participants as the problem-solving group* as well as *the formulation and determination of the approaches and solutions deemed acceptable by the problem-solving group*. Following the tenet of *ethnomethodological indifference*, there is neither pre-structure nor attempt to code our data.

Our Methodology:

The methodology used is set within the context of the Virtual Math Teams Project , which aims to encourage mathematical discourse online and eventually form a virtual community of math discourse. We examine the recorded chat logs and data streams of students engaged in mathematical problem solving for instances of negotiation. The 'criteria' for the identification of these instances do not come from pre-existing theories of negotiation, but from an analysis of what the participants in the recorded chats and data streams, recognize as negotiation.

We use methods developed from *conversation analysis*, basing our choice on research which seems to indicate that chat is similar to conversation. But our analytical method is different from conversation analysis because chat is different from conversation in many significant ways, among which is the disruption of turn-taking resulting in the phenomenon, much described in the research literature, of chat confusion. Furhtermore, the new circumstances created by computer mediation suggest adaptations of conversation analytic methods to make them more appropriate for the analysis of the VMT data. Thus we use a VMT replay application which permits us to approximate what each participant actually saw during an online, synchronous, collaborative mathematics problem-solving session.

Data Collection:

Data used for this research are taken from logs and data streams gathered by the Virtual Math Teams Project from 2004 till the present; additional data will be collected during the remaining three quarters of 2007. The data has different characteristics mainly because different online, synchronous collaborative environments have different features and consequently permit different kinds of interaction for negotiation. Data from 2004 were from VMT sessions which used AIM® (AOL® Instant Messenger) and thus exclusively used chat. Spring 2005 and Spring 2006 participants used ConcertChat and VMTChat respectively. Both have a shared whiteboard and chat window. VMTChat, a variant of ConcertChat, has features which are designed to make it easier to use for mathematics compared to ConcertChat. Spring 2007 participants will use a version of VMTChat which will have more features for mathematical discourse, in addition to features to facilitate social networking, possibly through the use of participant-supplied and community-assessed profiles.

Initial findings:

Initial findings show artful ways through which participants use both text and whiteboard postings to initiate, process and conclude negotiation. Participants allocate participation in the choice of approaches to a problem, the sequence in which different approaches are used and contribution to the execution of an approach through the affordances in the collaborative environment, often in ways not anticipated by the environment's designers. Participants invent new uses for tools, such as referencing mechanisms, introduced into iterations of the design of the VMTChat collaborative environment.

Significance:

We expect this research to contribute to a better description of negotiation in online, synchronous, collaborative mathematics problem solving in particular, and CSCL in general. We expect our findings to contribute to the identification of design features for CSCL environments. Such design features would enhance collaboration, surface perspectives and minimize unproductive conflict, leading to better support for negotiation.

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