Characterizing Discourse in an Electronic Community of Science Learners: A Case of the Kids as Global Scientists '97 Message Board

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1. Introduction

Rapid development of educational technology has changed the classroom learning environments in many ways. Internet access in public schools increased from 35% in 1994 to 78% in 1997 (National Center for Educational Statistics, 1998) indicating that the classroom is not an isolated place any more. The Internet provides students and teachers with enormous educational resources from all over the world and opportunities to communicate with each other in distant locations. Classroom walls are no longer boundaries as communities of learners are becoming larger (e.g. from a classroom with 1 teacher and 30 students to over 4,000 participants from different parts of the world in our project) and more diverse including not only teachers and students but also scientists, educators, businessmen and politicians. The changes in the scope/concept of the communities lead to changes in the interactions among their members. In order to understand these new learning environments, it is essential to examine the interactions among participants. In the traditional classroom, researchers have studied the interactions between a teacher and students or among students by looking at patterns in the discourse among the members. In a similar way, interactions among electronic community members can be examined by looking at their discourse mediated via electronic communication tools.

In this study, we will first examine the discourse patterns among the electronic community of learners who participated in the collaborative Internet-enhanced learning project, called Kids as Global Scientists. Specifically, we aimed to identify the unique characteristics of electronic discourse in K-12 educational settings and how the electronic discourse is similar to or different from the traditional classroom discourse. Second, we will discuss how the electronic discourse can support and sustain an electronic community of science learners and foster student scientific understanding and practice.

2. Theoretical Background

2.1. Discourse and Science Learning

From a sociocultural perspectives, learning is the result of participation in communities. Participation involves practicing the community's norms and is mediated by symbolic systems such as discourse (i.e. Lave, 1988, 1991; Lave and Wenger, 1991; Rogoff, 1990; Vygotsky, 1978). Therefore, the study of discourse as a mediating symbolic system is essential to understand learning as participation and practice.

A scientific community has its own way of communicating by sharing special language among its members. From this perspective, learning science involves practicing the norms of the scientific community and communication Learning science means, therefore, that students can communicate with each other and with other scientific community members using the socially shared language; they have learned how to “talk science” (Lemke, 1990). Examples of discourse common in science includes arguing, questioning, describing, and critiquing.

Many researchers have conceptualized scientific literacy as appropriation of the scientific discourse (Anderson and Palincsar, 1997; Gee, 1988; Latour and Woolgar (1986); Rosebery, Warren, and Conant, 1992), in contrast to the canonical scientific literacy which can be found in current science education reform documents (i. e. AAAS, 1993; National Research Council, 1996). Rosebery et al. (1992) stated that

> [this] view of science as a discourse helps us to see scientific literacy not as the acquisition of specific facts and procedures or even as the refinement of a mental model, but as a socially and culturally produced way of thinking and knowing, with its own ways of talking, reasoning, and acting; its own norms, beliefs, and values; its own institutions; its shared history; and even its shared mythologies (Rosebery et al. 1992, p 65)

Therefore, discourse study in the science classroom must not overlook the practice of scientific discourse, and the science classroom is the place where this scientific discourse is often being practiced by students and teachers.

2.2. Traditional Classroom Discourse & Electronic Discourse

A typical classroom can be portrayed with a teacher talking in front of 25-30 students. Most of the time, the teacher is either explaining topics, asking questions, or talking about other issues such as attendance or homework. Teacher and students discourse has been a main subject in classroom studies. The need for the study of classroom discourse to understand student learning has been addressed by many in recent decades because discourse study can provide us with a means to understand student learning as a social practice in the classroom. These studies have been focused on typical discourse patterns between teacher and students (i.e. Green, 1983; Hicks, 1996; Lemke, 1990; Mehan, 1979).

The traditional classroom discourse pattern is well documented by Mehan (1979). According to Mehan, Initiation-Reply-Evaluation (IRE) is the prevalent pattern of classroom discourse in most cases. A teacher usually initiates “instructional questioning” which already has a “right” answer. Students respond to the question, then the teacher evaluates students’ responses either positively or negatively. If a student’s answer is not what the teacher is expecting, then the teacher usually calls another student to answer the same question. Finally, “the answer” is provided by students or the teacher, and the teacher either elaborates further on the problem/question, or initiates a new question. Furthermore, 81.1% of total discourse sequences were initiated by teachers (Mehan. 1979, p. 80). A study by Bellack (1966) also showed that most talk in a classroom was initiated by the teacher and students did little more than respond to the teacher’s solicitations; students did not structure the discussion spontaneously (cited in Palincsar, 1984, p. 77).

The introduction of new technologies in the classroom has changed the nature of classroom interaction. In particular, computer-mediated communication technologies have altered traditional classroom discourse patterns. Increased group interaction, more equitable communication patterns, higher degrees of reflection, and time-and-place independent discussion are summarized as benefits of asynchronous, computer-mediated conferencing (Harasim, 1990; Eastmond, 1992; Hiltz, 1986, cited in Hewitt, 1997). However, these studies mostly focused on adult education involving a small number of participants. Also, the learning environments in these distance learning settings are quite similar to the traditional classroom with one or more teacher/moderators and students. The teacher assigns tasks or topics to discuss and then evaluates students' participation in discussion.

One well developed project that provides opportunities for young students to engage electronic discourse is the Computer Supported Intentional Learning (CSILE) project. CSILE is a networked system that gives students simultaneous access to a database that is composed of text and graphical notes that the students produce themselves and a means of searching and commenting on one anther's contributions (Scardamalia and Bereiter, 1991; 1992) However, this study was restricted to one or two classrooms within the same school; WebCSILE, which allows more users in remote location to participate, is being developed and studied, but its use with a wider range of K-12 students has not been well established.

Other types of electronic learning communities involve a large number of participants from different locations such as GLOBE, Global Lab, CoVis, and Learning Circle etc., among others. These projects allow students to collaborate with peers and experts who study the same topic area. Computer-mediated communication tools make this collaboration possible. However, studies on electronic discourse in these learning environments have not been established yet. There are many questions to be answered such as 'When do the participants talk each other?', 'How often do they talk each other?' . 'What makes them to talk each other?' , 'Why do they talk to each other?' , 'What kind of patterns characterize this kinds of electronic discourse?', 'How is electronic discourse in these learning environments similar to or different from the traditional discourse?' . 'Does this electronic discourse foster students learning?', 'If yes, how and why?'

This paper begins with an examination of the electronic discourse patterns among 4,000 middle school students during a collaborative inquiry based learning project. Secondly, we examine the types of student questions developed by students over time.

3. Research Background and Methods

3.1. Kids as Global Scientists

The Kids as Global Scientists (KGS) project funded by the National Science Foundation is an Internet-based atmospheric science program for middle school students. KGS participants engage in scientific investigations and take advantage of the powerful resources emerging technologies offer. During an eight week period, students study general weather phenomena by collecting and analyzing weather data, conducting hands-on experiments, and making predictions using the same real-time weather data that meteorologists use. Students work in small groups and each group specializes in one of four weather topic: Clouds & Humidity, Precipitation, Temperature & Pressure, or Winds. In addition, students have the opportunity to ask questions of the Weather Specialists, and communicate with other students in other places across the country to compare weather phenomena in different locations. As a vehicle for communicating with other participants, we provide an Internet-based threaded discussion area called the Message Board.

The project activities also encourage participants to take advantage of the power of first-hand resources, whether local or across the globe. Students begin by making self-introductions via the web-based Message Board to other students around the world. This is then combined with 2 weeks of data and information collection leading to the development of local expertise in one of the four topics in atmospheric science. A hands-on Real-Time Data Activity for each topic helps students to become familiar with and learn to interpret weather maps. During the next 3 weeks, students share their expertise with other groups world-wide who are participating in the same Global Exchange. In this way students develop understandings based on familiar instances first, then use these experiences as a foundation for developing an understanding of these same issues on a larger scale. Research in the cognitive and learning sciences strongly support this type of curricular progression (Songer, 1992).

The KGS program began in 1992 with 6 schools has since grown substantially to include approximately 80 schools from 5 continents involving over 4,000 students during the 1997 KGS Global exchange. Participants came from diverse settings including several students learning through homeschools, small rural schools, large urban and, special population schools, private Montessori schools and many others. Although the target audience was middle school students, we expanded our enrollment to include 4-5th and 9th grades. Participants were divided into 7 groups with 8-10 schools of similar ages, and a graduate student was assigned for each group to monitor Message Board activities for inappropriate messages and to offer support to the participants. During the eight-week of the 1997 Global Exchange approximately 5,000 messages were globally exchanged.

3.2. KGS and the Message Board

The web-based Message Board allows users to post and read messages and respond to other messages. The messages are displayed by threads on each topic, so it help users to see the flow of discussion. (see figure 1.)

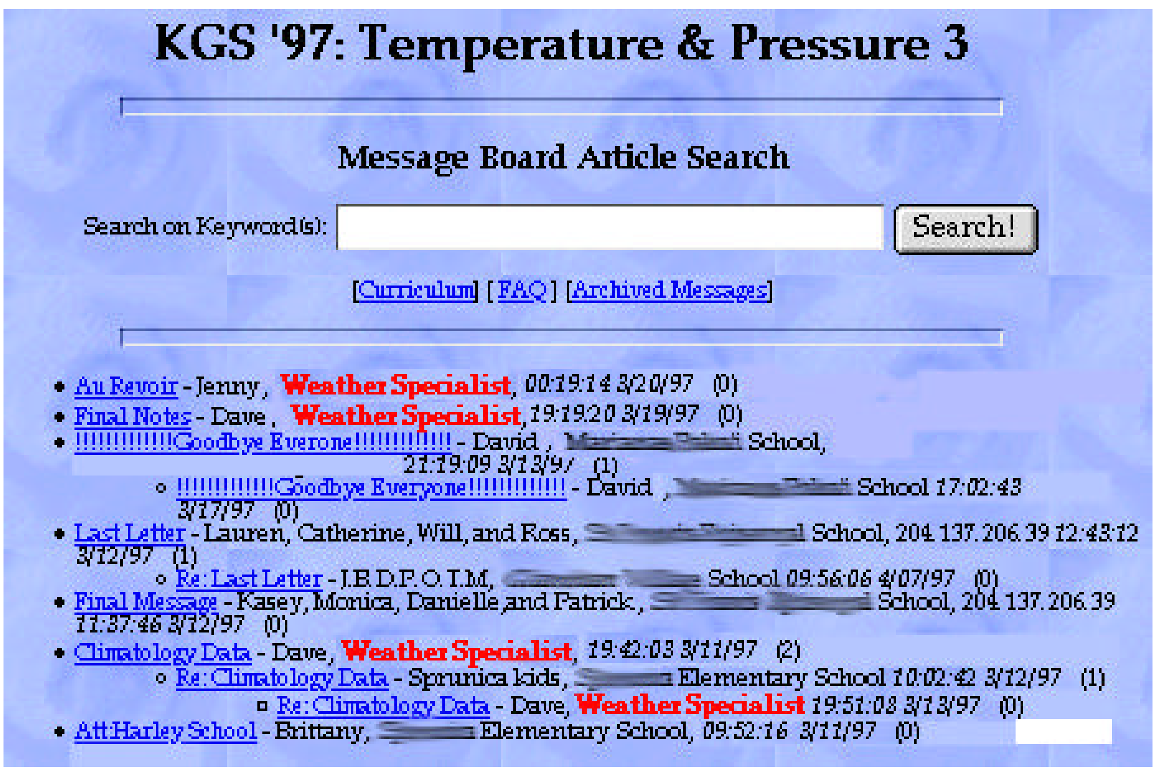

Figure 1. KGS '97 Message Board

The Message Board was designed to support knowledge development in a socially constructed knowledge community where interactions are mediated via electronic dialogue among peers and scientists. In designing the Message Board and other KGS features, we drew on distributed-expertise approaches (i.e. Aronson, 1996; Brown, 1992; Brown et al. 1992). We hoped to build a learning environment where individual experience and understanding was recognized and shared by other members (Songer, 1996; submitted). In addition, generating authentic questions on current topics in science is encouraged as an important learning experience. “Authentic” questions in our program can be described as questions dealing with both real and near-time professional data and information, and with first-hand experiences by participants (Songer, 1998).

Kids as Global Scientists can also be described as an electronic community of science learners whose shared goal is understanding natural weather phenomena by collecting and exchanging their observations and ideas with other participants. This electronic community of science learners (ECSL) is different from traditional in-class community of learners in several ways. While we developed and provided a CD-ROM with pictures of the students at the other sites, the participants in ECSL have never met each-other before. This ECSL is entirely created and sustained via electronic discourse.

4. Result: Electronic Discourse as an Essential Component for Building Electronic Community of Science Learners

4. 1. Specific tasks encouraged participants to use the message board more productively.

In the Kids as Global Scientists ‘97 curriculum, the primary uses of the Message Board were the “Introductory” activity in Phase 1 and the “Real-Time Data” activity in Phase 2. We believe that social interactions among participants in the beginning stage are a key factor to building the electronic community of learners throughout the program. Thus, we emphasized the importance of the introductory message exchanges at the beginning of the program. It helped participants know other participants from various locations as well as develop their own identity as KGS community members. Therefore, it is not surprising that 50% of the total messages (N= 4464) were posted in Phase 1, compared to 31% in Phase 2 and 19% in Phase 3. Figure 2 shows the percentage of messages posted in each week.

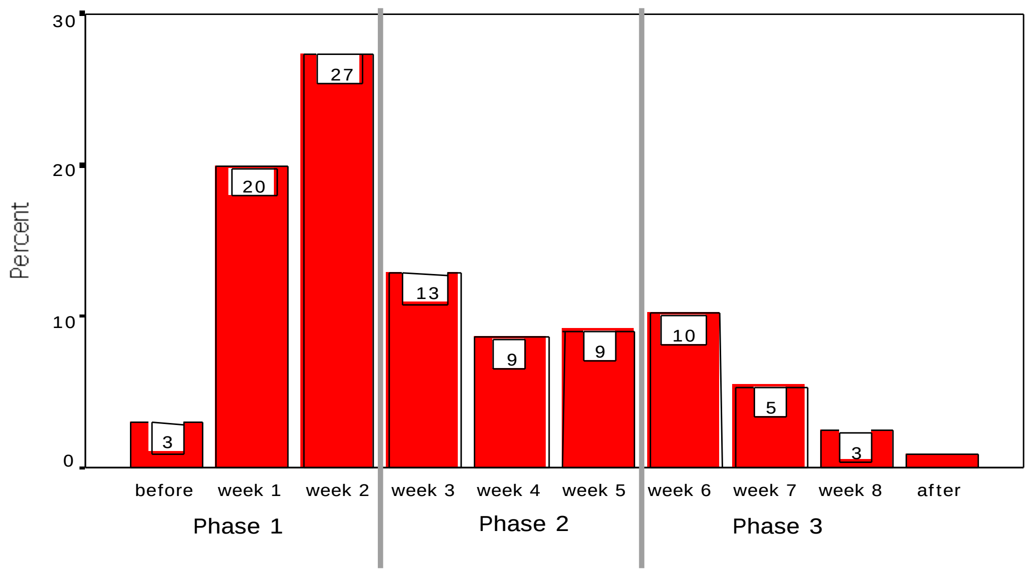

Figure 2. Percent of messages in each week during the KGS '97

While the "Introductory" activity was the main activity in Phase 1 which was designed to know each other and create a community among participants using the Message Board, other activities in Phase 2 and Phase 3 required use of the Message Board as a communication tool for sharing data and information among community members. The sense of community established by extensive communications among participants in Phase 1 was a key factor that supported sustained conversations and collaborations throughout the program in which students were willing to share their findings and understandings with each other. Because participants got to know each other by introducing themselves to the community, their writing on the Message Board became a meaningful activity both for the other community members as well as for themselves. Unlike typical writing tasks in the classroom that do not involve a real audience except teacher, when using the Message Board students wrote messages for a real audience who was interested in their messages.

"Real-Time Data" activity in Phase 3 allowed students to analyze "real-time" weather data using our real-time weather visualization tool. This activity was designed to encourage participants to practice a "prediction" inquiry process by investigating weather data that were the same as professional meteorologists study and forecasting a weather condition for one of the participant's school in the same cluster, then sending their prediction to that school and receiving the real weather condition from that school. According to sociocultural perspectives (Lave, 1988, 1991), learning occurs when people participate in a social practice of community. As their peripheral participation involving simple observation of other member's practice develops to full participation, newcomers become old-timers. In the traditional science classroom, opportunity to observe and practice "science" has been limited. The following two examples[1] show how electronic discourse encouraged participants to practice scientific inquiry through communication with other community members.

> *Posted by Precip. Group, S Elementary School, IN on March 04, 1997 at 09:00:18:*
> Dear H School [in New York], We are the precipitation group at S Elementary. We have just looked at "Blue Skies" and we have predicted that today, <u>Tuesday, March 4, your weather will be cold with light snow.</u> Please let us know if we were right or wrong.
>
> > *Posted by The truth Is Out There, H School, NY on March 12, 1997 at 07:17:43:*
> > Hi. You were about right in your prediction... <u>it was a bit colder Tuesday than it had been and we had a little bit of snow before school.</u> I wrote this to you before but we were disconnected as it was being sent in
> >
> > > *Posted by Precip. Group, S Elementary School, IN. on March 13, 1997 at 06:27:11:*
> > > Hi. We received your letter, we're are glad to here from you. We've gotten pretty good at predicting the weather<u>. We think you will have rain within the next 48 hours</u>. Let us know if were right.
> > >
> > > > *Posted by Kim and Carol, H School, NY on March 19, 1997 at 07:45:46:*
> > > > <u>On March 14 we had an Ice Storm and we didn't have any school!!</u>

> *Posted by S Elementary IN. on March 07, 1997 at 10:44:31 :*
> Hi, GV School students [in New Hampshire]. <u>Have you been having a lot of blizzards lately?</u> Our weather maps here showed very low barometric pressure in your area. How low was your barometer yesterday (3/6) during your bad weather? Is there a lot of cloud cover in your area? How much snow do you have?

[1] All participants' names used in this paper are pseudonyms.

> *Posted by Pressure On The Mind, GV School NH. on March 07, 1997 at 11:45:42:*
> I don't know how low the barometer was the other day but I think that it was low. We had a blizzard warning advisory in affect for most of New Hampshire. We have about 1 foot of snow now. The cloud cover here today is about 90% but the other day our cloud cover was 100% and it's been seasonably cold.
>
> > *Posted by S Elementary IN. on March 07, 1997 at 12:16:11:*
> > Is there any way you can find out how low the barometer was? We're very interested in that storm? If not that is okay. Thank you for the response.
> >
> > > *Posted by Pressure On The Mind. GV School NH. on March 17, 1997 at 10:51:20:*
> > > I don't know if we can find out how low it was. The reason that I don't think we can is because we don't have one at school.

4. 2. More student-student communications were encouraged compared to a teacher-dominant classroom conversation.

In the traditional classroom, most classroom discourse is dominated by a teacher or a small number of students who more actively participate in classroom discussion than others. Other rather shy and less active participants have little opportunity to speak up in the classroom. Moreover, most of the time, classroom discussion is led by a teacher. S/he explains and asks questions and students usually show passive participation such as providing short, yes/no answers or even just a nod. On the Message Board, however, student participation was more active than adult participant at least in terms of the numbers of posted messages: 82.8 percent of the total messages (N = 4464) were posted by student participants.

How did participants talk to each other?

The Message Board allowed participants to either post a new message (original message) or reply to already posted messages (follow-up messages). The Message Board is a vehicle for participants to exchange and share their ideas and experiences, and develop new understandings by working (discoursing) with others who are studying the same topics in remote locations. Thus, we could observe more continuing dialogue among participants — between students-students and students-scientists. Figure 3 shows 60% of the total messages (N = 4464) were follow-up messages to other messages.

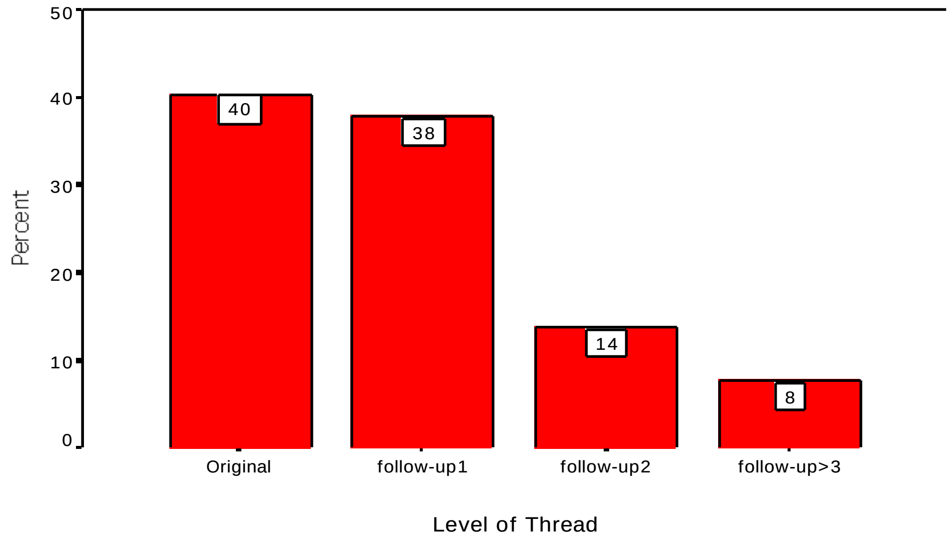

Figure 3. Percent of messages by level of thread

These data shows us that participants were not just posting a message, rather they read other messages and communicated with each other by replying to other messages. This threaded function of the Message Board allows participants to take advantage of socially shared knowledge construction. Because the messages were being read by other participants who then replied to the messages, the senders of the messages had to be careful about their own messages, and by receiving others' comments they can rethink their original messages and revise their ideas. Students also come to realize that they do not need to know everything, rather, they are learning what they did not know before by asking others who do.

Furthermore, Figure 4 showed that while 44% of the total student messages (n = 3695) were “original messages” on a topic thread, only 24% of the total adult-participant messages (n = 769) were “original messages.” This illustrates that while students started threads of discussion, the scientists and the cluster manager more often responded to students’ messages rather than initiating a new thread of conversation.

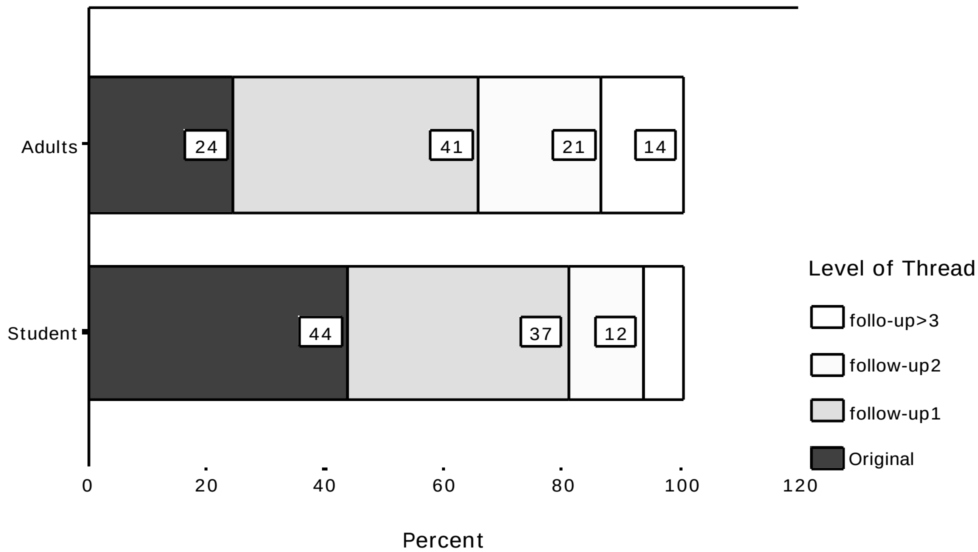

Figure 4. Percentages of each thread-level messages posted by adults and students respectively

4. 3. An electronic community of science learners was established and sustained through socialization among participants.

It was an essential role of the Message Board to build an electronic community of science learners among participants in distant locations. Based on work by Goldman(1992) and others on the "social glue", we believed that in order to collaborate with other people in remote locations who had never met before, it was important to know about each other and identify shared common goals throughout the project. Therefore, the first two weeks of our project was designed to facilitate participant communication. Participants introduced themselves to each other and described their local weather and geographic surroundings. They began to recognize differences among participants' geography and weather as well as forming social bonds among themselves by recognizing common interests as community members. This motivated students to talk to each other to understand differences and similarities among participants and they were excited about studying together during the project. The following examples of message exchanges show typical introductory messages posted by students.

Posted by Don, MB School, Guam on February 17, 1997 at 16:26:27:
Hello, My name is Don and my school is very small; it only has ten kids. We are trying to learn as much about the weather as possible. There are only two people in the temp. group. Andy is 12 years old and he enjoys scuba diving, soccer, and video games. Don is 13 years old and I like to play soccer, football, and video games. Usually the temperature is about 83 degrees F.

> *Posted by Mary, GM Middle School, VA on February 20, 1997 at 07:09:55:*
> Hello from Virginia, USA. What is it like to live in Guam? It must be wonderful with the weather and all. Where do you live in Guam? What school do you go to? Got to go. Nice talking to you. Hope to talk to you again.
>
> > *Posted by Don, MB School, Guam on February 23, 1997 at 17:23:14:*
> > This Don, I live in a small village and it is like a suburb for the island. The weather is not all that good when you live here for a long time, but the best time is right after a typhoon (that is like a hurricane). The weather is too much the same, I mean if you come in the dry season the weather is almost always going to be dry. See, we only have two seasons, the wet and the dry. I go to MB School, which is a very small school. It only has ten students but we are getting one more.
>
> *Posted by David, GM Middle School, VA on February 20, 1997 at 07:01:37:*
> Hello, my name is David. I go to GM Middle School in Virginia. I'm eleven years old. I like playing video games and playing sports. GM Middle School is a lot bigger than your school; the Middle School has about 400 people. It's colder here. Today it's really warm- 53 degrees. Normally it's in the 30's in the winter. What season is it in Guam? How hot does it get all year? I'd really like to know.
>
> > *Posted by Don, MB School, Guam on February 23, 1997 at 21:23:43:*
> > Hello, this is Don as you know, I think.? So- there are 400 students in your school. The last school I went to had over 1000 students, I think? But this school I am going to now is much weirder then my last. Like to hear from you.

Posted by Nina, Gail, Lisa, Ann, D Elementary School, B. C. Canada on January 28, 1997 at 14:21:19:
Hi, We're from B.C. Canada. This town is surrounded by mountains so therefore we have lots of animals such as: deer, bears, cougars, woodpeckers, chickadee's, robins, salmon, hummingbirds, trout, grouse, chipmunks, and squirrels. Right now its really cold. Two days ago it was -26C last night it snowed about 15 cm. In the summer it can get up to about 30 degrees above. What's the weather like where you live?

> *Posted by John, Matt, Bill, GB School, Queensland. Australia on February 11, 1997 at 17:33:54:*
> Hi girls! We are from Golden Beach in Australia. This morning it was 26C and the weather was warm. It is strange how in your area 26C produces snow. Cold weather only comes when the temperature drops to around 17C, but we still don't get snow. Do you think there is an explanation for this? Bye for now.
>
> *Posted by The Fog Family, L Middle School, MI on February 11, 1997 at 08:28:38:*
> Our weather is very cold in the winter, we can get up to about 5 inches of at one time. In the summer we can get up to 100 maybe. Spring it's nice and cool most of the time, but sometimes it can get a little warm. Fall is cool and kind of breezy.
>
> *Posted by Ken, MB School, Guam on January 29, 1997 at 20:14:06:*
> The weather on Guam is hot and a storm has just passed by.

> *Posted by from Weather Specialist, on January 28, 1997 at 22:04:40:*
> Hi Nina, Gail, Lisa, Ann! Here in Iowa, USA we have had some cold weather lately. Last night it was down to about -20C. That is colder than it normally is this time of year. In the summer we get over 100F (over 38C) occasionally. It sounds like our temperatures are somewhat alike. I hope you guys are looking forward to this project as much as I am.

Severe weather such as hurricanes, tornadoes and flooding are popular topics of discussion among participants. Whenever unusual weather phenomena happened, the participants who were experiencing the phenomena reported their first-hand experience on the Message Board, and these first-hand experiences drew other's attention to talk about more. In the middle of our program, there was a flash flood in the Houston, Texas area. After students in Houston posted a message regarding their flood, other participants responded to that message showing them concern the situation.

> *Posted by Emily, Cheryl, Joe and Key, SFE School, TX on February 12, 1997 at 11:54:19:*
> Today in Houston <u>it is pouring rain and there is a flash flood. All of the windows are foggy.</u>.
>
> > *Posted by Henry, GM Middle School, VA on February 20, 1997 at 06:40:55:*
> > Hi to people from Houston, <u>How's the flood doing? How is everyone in Houston?</u> .. Well, I don't have a lot of information about the weather here in Virginia. These few days have been very warm and pleasant. It's still winter here, but it feels like Spring. Got to go! Hope to hear from you soon! I'll write back. Bye-Bye!
> >
> > *Posted by GM Middle School, VA on February 20, 1997 at 06:31:40:*
> > Hi, <u>How bad is the flood? Is it still flooding there?</u> Tell me about everything. Tell me your names. I want to know everything.
> >
> > > *Posted by Emily, Key, Joe, and Cheryl, SFE School, TX on March 03, 1997 at 11:36:00:*
> > > Hi, <u>The flooding wasn't that bad w[h]ere we live.</u> Pasedena got hit by a tornado a few weeks ago. We have had some rain and its been overcast... It was really cool and the weather was pretty good. At night the you can see all the stars. Well, write back soon.

Socialization among participants through electronic communication was observed through all phases. For example, half of the total messages (N = 627) posted in Cluster 3 Message Board had some social content. Figure 5 shows the percent of socializing messages which were posted in each phase.

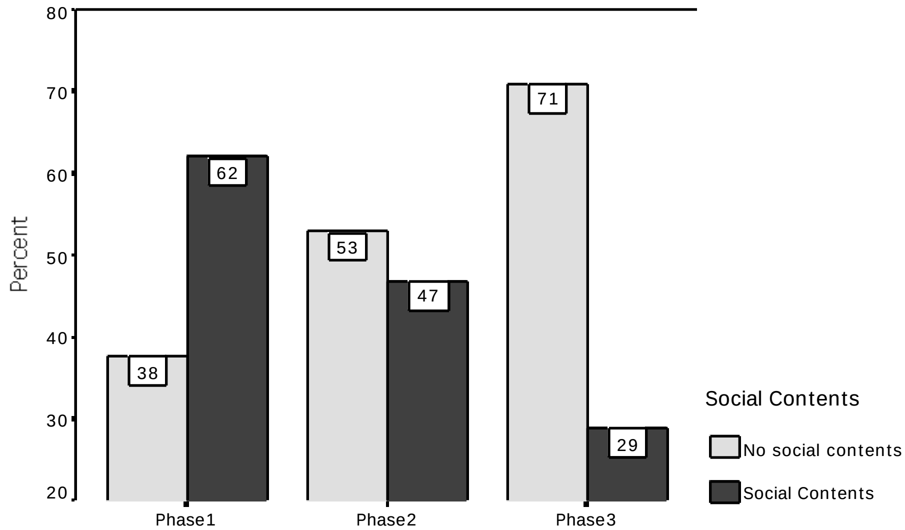

Figure 5. Percent of socializing vs. non-socializing messages in each phase (Cluster 3 Message Board)

Even though the percentage of messages that include social content decreased from 62% in Phase 1 to 47% in Phase 2 to 29% in Phase 3, participants still cared about each other, and showed interest in other community members throughout the whole project.

Previous studies showed that a traditional science classroom can be more favorable for a certain group of students. The AAUW reports (1995) showed that statistically significant differences in achievement levels between boys and girls. Other research reported that certain types of discourse patterns in traditional classroom prevent minority students from appropriating school norms (Gee, 1988; Rosebery et al., 1992). Electronic discourse can be one solution for this unequal learning opportunity found in the traditional classroom. Hsi and Hoadley (1997) found that the anonymity of electronic discourse can contribute to more participation of girls in electronic discussions. A KGS teacher from an urban middle school told us that she noticed more girls showed interest in science after they were introduced to the Message Board. The girls *loved* talking to other participants about their school and about the weather. It seemed that the excitement in communication with others provided the girls who had had little interest in science with the opportunity to "talk science" in different ways. A case study with two KGS '97 participating classes also illustrated girls' perception of difficulty in learning science decreased significantly (Kam and Songer, 1998).

4. 4. Sharing personal experiences of participants provided each other with a broader understanding of weather phenomena and related scientific concepts.

The large number of participants and the diversity among KGS participants provided a richer learning experience than simply one, rather homogenous, classroom. Participants from various locations brought their personal experiences into the conversation. For example, students in Hawaii described their yearly hot weather. Then, a student from Michigan replied to this message saying that he was surprised by the fact that Hawaii never gets snow. Year-long, summer-like weather might be boring for a Hawaiian, but this same fact can be very interesting for other students who experience snow every winter and have not thought about a place without snow before. For the Michigan student, weather/climate was conceptualized with four seasons. After communicating with the Hawaiian students, his conception of weather/climate was extended. Even by exchanging their simple first-hand experiences which might be so obvious to themselves, other participants can obtain valuable information. By appreciating the first-hand experiences in science class, they have learned that science is not something “Scientists” do in the laboratory or the field, but is something which includes everyday experiences.

During a Phase 3 Data Comparison activity, a group of students in Indiana noticed Guam was the only school with a high temperature of 80°F, and asked those students about what their cold weather was like. The students in Guam responded by saying that because they are near the equator, their coldest temperature is around 60°F. This example illustrates how scientific data exchange and personal experiences can enhance learning through the development of rich understandings.

Posted by Beth, S Elementary School, IN on March 11, 1997 at 09:40:46:
HI! We just finished mapping out your temperature, for those 2 weeks in February, that you sent in weather data. While I was doing that I noticed that you were the only school with temperatures in the 80's. Almost all the other schools were in the 30's, including us. What is the coldest it has ever been at your school?

> *Posted by Don, MB School, Guam on March 11, 1997 at 18:00:48:*
> Hello, so you mapped our temperature. What do you think about the temperatures we're having? We're close to the equator; that is why we have the temperatures in the 80s all year around. The coldest temperature we have is somewhere in the 60s. Like to hear from you again, Don.
>
> > *Posted by Beth and Joan, S Elementary School, IN on March 12, 1997 at 09:57:04:*
> > Hello, we think your weather is pretty neat. Over the winter, it got to be -15, a few times [in our area]. I think you guys in Guam would really like snow. Do you have tornadoes where you live?
> >
> > > *Posted by Don, MB School, Guam on March 12, 1997 at 20:15:01:*
> > > Hello, well if you live here for all your life you would not like the weather here. You asked if we get tornadoes here, well we don't because the island we live on is only 32 miles long but we do get water spouts. Do you know what a water spout is?

4. 5. Real-Time and near-time events encouraged students to talk about the events and led to developing scientific understanding.

Mehan (1979) proposed that the reason why classroom discourse has an evaluative phase is because the asker, or the teacher, has information unlike everyday conversations. This type of question has been known as “requests for display”, “test questions”, “information probing questions” and “known- information questions”. On the other hand, in most other conversations, the asker does not have information; the asker ask questions to obtain new information. This type of question has been called “request for information”, “information-seeking questions”, and simply “real questions” (Mehan, 1979, P. 194-195). It seems that the different question types asked by teachers in classrooms and asked by students on the Message Board contribute to the uniqueness of electronic discourse. Furthermore, this opportunity for students to ask “real questions” encourages students to practice science by engaging in inquiry.

Scardamalia and Bereiter (1991, 1992) investigated student generated questions in two different learning environments — the text-based condition and the knowledge-based condition — and illustrated under the knowledge-based condition that students generated more “wonderment” questions which reflect curiosity, puzzlement, skepticism, or knowledge-based speculations, rather than "basic information" questions that ask for orientation to a topic and can often be answered by a textbook. Scardamalia and Bereiter further proposed that the type and quality of student generated questions can be characterized by the learning environment in which the questions are formulated and recognized. Collaborative learning environments of KGS established by socialization among participants and by opportunities to study real-time events as they happen allowed students to ask real-time and real-life situated questions. In addition, these questions provided students opportunities to develop scientific understanding by communicating with scientists and students who were experiencing the events at the first-hand.

The KGS electronic community of science learners allowed participants to discuss real-time events as they happened. When sensational weather phenomena such as hurricanes, tornadoes, and floods happened somewhere, participants in those locations reported their first-hand experiences of these events. This in turn brought other participants' attention to the real-time events and they pursued more studies of them.

Posted by Jeff from SFE school, TX on February 27, 1997 at 08:50:31:
For the past few days it has rained continually. It must have rained in the north too because many rivers and lakes have risen. We use the Internet to get an update on weather there. We now have 6 computers in the class on-line. Also, hail can be picked up in the sky over and over again. <u>Can it be carried over long distances? If so, could it be hailing in someplace where there are no clouds in the sky?</u>

> *Posted by Jeff, SFE School, TX on March 06, 1997 at 09:02:08:*
> Dear Nick, In the north we have been experiencing heavy rain. The Ohio River is Flooding and major rivers are flooding down here. We have had rain all week but the weather has finally changed! It is cold and windy. <u>Should we expect more rain because of the rivers ?</u>
>
> > *Posted by Nick, Weather Specialist, on March 10, 1997 at 13:40:26:*
> > Glad to hear you are finally starting to dry out! As for getting more rain because of the rivers, I had always thought that if it rains here in Delaware, the water must have come from a nearby lake. But, as it turns out, most of the rain you get probably started out far away from you, possibly even as ocean water.
> > One way to look at it is to look at a map of the U.S. <u>Notice how small the Ohio river looks at that scale, then remember how big an area it was raining over.</u> Anyway, hope you don't get that much rain again for a while!
>
> *Posted by Donald., GM Middle School, VA on March 06, 1997 at 08:04:34:*
> Speaking of non-stop raining in towns that border the Ohio River. All towns are waist - high in water. So watch the news and see about it.

Posted by Nick, Weather Specialist, on February 27, 1997 at 23:16:54:
Anyway, that's a good question -- but what do you mean by a long distance? If a cloud gets high enough, it can get an 'anvil' top on it, and you can have rain out in front of the main part of the cloud. If it's windy, this rain can be carried even further from the cloud. But, hail, as you pointed out, occurs when a little bit of ice is carried back up into the cloud, falls and picks up more ice on the way, and is then carried back up again, over and over until it is too heavy, and falls out of the cloud. This means the hail can't travel away from the cloud as it's forming. But, on it's final trip back up, it can get caught in that anvil section of the cloud and fall out. My guess, though, is that it wouldn't travel too far away from the cloud on its way down to earth like rain sometimes can.

Not only the students but also the scientists asked real-time, real-life situated questions. The following exchanges show how a weather specialist used a real-time event, heavy fog, as an opportunity to present an authentic question to students, especially residents in that area.

Posted by Weather Specialist, on February 04, 1997 at 02:52:20:
Hello Mike, Jack, Lee and Sue: Well, while you all were sleeping soundly in Houston last night, I was having a tough time with your weather! Delta Flight 101 was inbound to Houston's Hobby airport and the fog moved in quickly and we couldn't land there! Question: What direction do you think the wind was from when the fog "rolled" in? Fortunately the weather at Houston's Intercontinental airport was better and Delta 101 landed there instead. That just meant some of the passengers had to take a bus ride downtown :(Now it's about 4:00 a. m. Central Standard Time and the fog has moved out of the Houston area entirely. The winds are now out of the southwest at about 12 miles per hour. Ya'll have a good day, and work hard!

Posted by Jim, Nicholas, Alice, and Christine, on February 05, 1997 at 13:23:31:
My answer is that the winds came out of the south. I have a question for you: What is the average wind speed in Houston? Would you please reply?

Posted by Weather Specialist, on February 06, 1997 at 21:09:40:
Good answer! Winds from the south and especially the southeast in Houston bring warm, moist air in off the Gulf of Mexico and can cause heavy fog conditions. To answer your question, I'm looking in a book of climatological data. Climatology is the study of weather history. The average wind speed in Houston, Texas is about 8 mph, with the average (or prevailing) direction out of the south-southeast. In August, 1983, Houston reported a wind gust to 83 mph! Wow! You all have a great weekend.

Posted by Mike, Jack, Lee and Sue; on February 06, 1997 at 13:58:50:
Hello from the winds group, sorry Jerry about our weather on flight 101. We don't usually have that much fog. We're guessing the fog rolled in from the north, but then again we're not that smart! How's the weather in central New York? See ya

Posted by Weather Specialist, on February 10, 1997 at 01:50:46:
Hello, Mike, Jack, Lee and Sue: Here's a clue to my fog question: Where is the biggest body of water around Houston (I know, too easy, huh?) That's where the fog rolled in from.

The first group of students provided a correct response, even though they did not include any reasons behind their answer. Then, the question of wind direction led to other questions about the average wind speed in the same area. The response of the scientist to these questions provided not only the information the students asked but also the source of information where the scientist located the answer. Thus, through this conversation, students could observe the scientist's inquiry process— problem solving and information searching. The second group of students guessed the wrong wind direction. Then, the scientist helped them to understand by raising another question as a clue for the first question. It was also interesting to see how the second group of students personalized the natural phenomena as if it were their own fault*; "sorry Jerry about our weather on flight 101. We don't usually have that much fog".*

Hurricanes '97[2] was another collaborative inquiry-based science program for middle school students. This theme-based Internet-enhanced program provided participants an opportunity to understand weather phenomena by investigating a sensational natural phenomena, hurricanes. During this program, several real hurricanes and tropical cyclones occurred and those events led students to ask real-life situated questions which can not be answered by textbooks.

> *From: Penguins T School Date: Thursday, October 09, 1997 02:08 PM*
> We have three questions:
> Do you think El Nino is really keeping hurricanes from forming in the Gulf of Mexico this fall? What makes El Nino reverse the direction of the flow of warm water across the Pacific? Does El Nino mean we may get more snow in Fort Worth this winter? We hope so! :-)
>
> > *From: Hurricane Specialist Date: Friday, October 10, 1997 03:53 PM*
> > > Do you think El Nino is really keeping hurricanes from forming in the Gulf of Mexico this fall ?
> > Definitely! Aug and Sep were the least active peak months of hurricane season since 1944.
> > > What makes El Nino reverse the direction of the flow of warm water across the Pacific?
> > The winds pushing the currents reverse direction. The reason for the reversal of wind direction is not well understood, and is the topic of mush research.
> > > Does El Nino mean we may get more snow in Fort Worth this winter?
> > It means you will get more precipitation, more than likely--but whether it will be snow or rain, who knows!

[2] For more detailed descriptions about this program, see Lee, Y. J. and Songer (1998) and Lee, H. -S and Songer (1998).

> *From: C Home School Date: Friday, October 10, 1997 01:17 PM*
> We have 2 questions. First, why was Hurricane Pauline called a hurricane and not a typhoon since it was in the Pacific Ocean? Also, we saw a large swirling mass of clouds near British Columbia (in the Pacific Ocean) on the satellite images. What was it? We saw it on Wednesday. Thank you.
>
> > *From: Hurricane Specialist Date: Friday, October 10, 1997 04:15 PM*
> > > why was Hurricane Pauline called a hurricane and not a typhoon since it was in the Pacific Ocean?
> > They are called typhoons only if they are in the Western Pacific (west of Hawaii). Eastern Pacific tropical cyclones are called hurricanes.
> > > Also, we saw a large swirling mass of clouds near British Columbia (in the Pacific Ocean) on the satellite images. What was it?
> > That was a mid-latitude cyclone, the familiar "lows" or "low pressure systems" you hear the weather forecasters talk about, that give us in the U.S. most of our rain and snow.

4. 6. Scaffoldings by the experts help students develop scientific understanding.

Scientists' participation on the Message Board helped students develop better scientific understanding. In the electronic community of science learners, some questions were difficult to answer by teachers because the questions and problems were real, not text-based, and answers were often not determined. Thus, this required content expertise in the topic areas. This is well illustrated in students' questions to scientists. Students' questions posted on the Message Board were often inquiry-based, real problem-related, and contextually situated which cannot be answered by any textbooks. In addition, communication with the scientists motivated students to talk about science. Communication with scientists make students realize they are part of a scientific community and encourages them to talk about science. During a teacher interview after the program was over, the teacher told us that her students were thrilled when they got responses from "the Scientist."

The following two examples are the cases where the Weather Specialists raised "interesting" questions and students got excited to know more about what the scientists had to say.

> *Posted by Douglas, **Weather Specialist**, on February 13, 1997 at 20:37:28:*
> Yesterday, we had a strange thing happen in Pittsburgh. We had a Thunder-Snow Shower (complete with lightning). This is a rather unusual thing and very beautiful (if your a weatherman). Have any of you ever seen this happen?

Posted by Don, MB School, Guam on February 24, 1997 at 17:29:24:
Hello,
What is thundersnow? I live in a small island called Guam, so I don't get thunderstorms that often. Is thundersnow like a thunderstorm but with snow instead of rain?

Posted by GB School, Queensland, Australia on February 17, 1997 at 17:37:40:
Hi Douglas! No we have not seen it. Can you please send us some more information about Thunder- Snow Showers?

*Posted by Douglas, **Weather Specialist**, on March 02, 1997 at 13:28:37:*
Don, You have it right. It is a thunderstorm with snow instead of rain. Thunderstorms with snow are a rare event since the atmosphere usually doesn't contain enough energy to cause a thunderstorm when it's that cold. If a storm system with that much energy were to move through during the spring, there would probably be tornado warnings issued. I have witnessed this phenomenon a couple of times. During these events, there is very heavy snow in a short time, and the lightning looks a very strange yellow color through the snow. It's a very beautiful sight.

Posted by Cumulus Kids, GV School, NH on January 29, 1997 at 10:07:13:
What's your favorite cloud?

*Posted by Chris, **Weather Specialist**, on January 29, 1997 at 20:51:31:*
My favorite cloud is the cumulonimbus. Do you know what type of weather is associated with a cumulonimbus cloud? If you do you might be able to figure out what one of my hobbies is. Let me know: 1) What weather is usually found with a cumulonimbus. 2) Take a guess at what hobby would be related. (If you need a clue with the hobby let me know)

Posted by Cumulus Kids, GV School, NH on February 06, 1997 at 08:03:26:
Cumulonimbus clouds are associated with high wind speed and thunder storms. We were guessing that it would be hang gliding or ballooning we were wondering if you do any of these sports?

*Posted by Chris, **Weather Specialist**, on February 07, 1997 at 10:04:40:*
Hello Cumulus kids. You sure know your clouds! I have never hang glided or went ballooning, but I am a private pilot (but that isn't the hobby I am talking about :)) Cumulonimbus clouds are usually associated with bad weather, so I don't think to many people would want to hang glide or balloon near them. I'll give you another clue about the hobby I am talking about: Have you ever seen the movie Twister??

Posted by Emily, Cheryl, Joe and Key, SFE School, TX on February 05, 1997 at 11:57:06:
We found that Cumulonimbus Clouds are usually accompanied by heavy thunderstorms. We need some more clues to help us guess your hobby.

Posted by Chris, Weather Specialist, on February 07, 1997 at 10:08:08:
Well Emily, Cheryl, Joe and Key you sure know your clouds!!
Here is the next hint: Have you ever seen the movie Twister?

The following message exchanges show that how students and scientists were developing scientific ideas through communication. This is a sample electronic message exchange between two middle-school student groups and a scientist, the Hurricane Specialist. The underlined portions indicate how dialogue between students and the Specialist evolved over time. The first group of students raised a simple factual question and the scientist responded. Then, the second group of students asked for an explanation about an unfamiliar scientific term, “sustained winds.” After the scientist helped these students to understand that sustained winds are measured at 10 meters above the ground, the students became curious about how wind speed changes vertically as well as horizontally, and proposed their explanation of a relationship between wind speed and wind direction at different levels. These messages illustrate one example of how young students practice science through their participation in a scientific community and the communication of scientific ideas between peers and scientists.

Date: October 09, 1997 12:17 PM From: S Middle School
How fast was the fastest <u>wind speed</u> in a hurricane?

> *Date: October 09, 1997 12:29 PM From:* ***Hurricane Specialist***
> Hurricane Camille was estimated to have <u>sustained winds</u> of 190 mph and gusts to 230 mph when it hit Mississippi in 1969.
>
> > *Date: October 14, 1997 03:03 PM From: I Homeschool*
> > <u>Where</u> are the <u>sustained winds</u> in a hurricane measured?
> >
> > > *Date: October 14, 1997 04:51 PM From:* ***Hurricane Specialist***
> > > Sustained winds are <u>measured at</u> 10 meters above the ground.
> > >
> > > > *Date: October 15, 1997 06:58 PM From: I Homeschool*
> > > > Is that <u>measured in</u> the eye wall or at some other horizontal spot? Also, does a hurricane have <u>higher or lower winds higher up</u>? I think there would be high incoming wind speeds at the bottom and high outgoing wind speeds at the top and in between high up-going wind speeds.
> > > >
> > > > > *Date: October 16, 1997 11:35 AM From:* ***Hurricane Specialist***
> > > > > Is that measured in the eye wall or at some other horizontal spot? Max winds are always in the eyewall. Also, does a hurricane have higher or lower winds higher up? The maximum wind speed are found around <u>1000 feet above the surface</u>; near the surface, friction slows the winds down by about 15-20%. Winds gradually decrease from 1000 feet as you go higher up.

6. Discussion

In order to study how participants were able to build a socially constructed knowledge community through electronic discourse, all the messages on the KGS '97 Message Board were analyzed. A total of 4,464 messages were tabulated with the information on posting date, sender, topic group, cluster, thread level, and content of each message. This information provided us with general patterns of Message Board use during the program. The content of messages was analyzed to help us understand how electronic discourse can support the building of an electronic community of science learners and foster student understanding. The following themes emerged:

1. Specific tasks encouraged participants to use the Message Board more productively.
2. On the Message Board, more student-student communications occurred compared to in a teacher-dominant classroom.
3. Socialization among participants helped to establish and sustain an electronic community of science learners.
4. Sharing personal experiences of participants provided each other with a broader understanding of weather phenomena and related scientific concepts.
5. Real-Time and near-time weather events stimulated conversation about the events and led to the development of scientific understanding.
6. Scaffolding by the experts helped students develop scientific understanding.

Developing "social glue" among participants and building "identity" as members of the electronic community of science learners were key factors in making electronic discourse more productive. From the beginning, participants shared their common goals, studying weather phenomena around them in this program by talking to each other and introducing their weather and surroundings as well as themselves. The awareness of a sense of community encouraged them to work together and share each other's experiences as valuable resources for developing understanding.

In addition, electronic discourse on the Message Board showed that KGS participants practiced scientific inquiry which was, in several ways, similar to the way scientists practice inquiry. Students collected their local weather data and compared them to other students' data in distant locations. They also used professional data provided by the interactive visualization tool as a resource for developing a broader understanding. Students analyzed the data and looked for patterns, then made weather forecast based on their understanding. Their weather forecasts for a certain location were then checked with the students resident in that location. In addition, real-time weather phenomena provided students with opportunities to engage in inquiry by asking situated questions and researching those questions.

We also found that a well-coordinated curriculum (e.g. careful selection of content and related-resources, appropriate sequence of activities and classroom-supportive technology) could support building the active electronic community of science learners. Specific tasks in time (such as the "Introductory" activity at the beginning of the program, and the "Real-Time Data" activity in Phase 3, when students have developed basic understandings of local weather phenomena) provided participants with opportunities to build socially constructed knowledge. In addition, advanced technology such as organized sorting functions (e.g. sorting messages by date, by senders, or by topics) or the automatic prompting system on the Message Board can also support building of an electronic community of learners. Furthermore, as the scale of the electronic community increased, management of the huge volume of messages became a challenge. More research is needed on issues associated with a large scale of participants in an electronic community.

In spite of increasing interest in the use of Internet-based technology in the classroom, research on the effects of these technologies on learning and teaching are still limited. Previous studies in this area have been focused on the development of technology itself and have reported only anecdotal evidence of the effect on student learning and motivation. More extensive work can be found in the Distance Education area, but this research is primarily concerned with post-secondary students rather than K-12 students. We have just begun to systematically examine the effects of newly emerging technologies on student learning and teaching in K-12 school settings. This study of electronic discourse, which examined how electronic discourse could support building of a community of learners and foster student learning can serve as a starting point to expand our understanding of this area.

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