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Title: **"It Doesn't Take a Rocket Scientist: Multi-layered Perspectives on Collaborative Learning Activities in a Middle School Rocket Simulation Project"**

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Presentation: **Work-in-Progress**

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Work-in-Progress Proposal

"It Doesn't Take a Rocket Scientist: Multi-layered Perspectives on Collaborative Learning Activities in a Middle School Rocket Simulation Project"

Abstract

This report of work-in-progress presents themes that we see emerging from the microethnographic analysis of videotaped interactions among a teacher and five middle school students working with a computer simulation of rockets. The teacher and students can be observed negotiating and engaging in multi-layered perspectives on their activities. As researchers interested in the use of "cognitive artifacts" like computer simulations and in educational interactions within everyday school practice, we are trying to discover and interpret what takes place from multi-layered perspectives as well.

We are part of an interdisciplinary research group with interests in communication in urban institutional settings such as schools, in issues of collaborative learning, in the design and adoption of educational technology, and in the cognitive role of computer-based tools. We proceed primarily through collective microethnographic analysis of video recordings – generally of small groups using technology. In the session being presented, the simulation designer took his software into the classroom to see how the students would use it. He guided the students through a sequence of tasks by responding to their behaviors and modeling scientific procedures and formulations. Subsequently, he joined our group analyzing the tape as a participant observer.

We watch the students work with the rocket launch simulation, identifying the effects of various features of rocket design for potential use in the design of their own physical model rockets for their group project. Of particular interest to us are the situated ways in which the students interact with the simulation artifact: they can be seen to be engaging it by turns as a technological artifact that can be manipulated, as a dramatic event in which they participate, and as a cognitive tool for collaborative problem-solving. In the presentation, we will identify multi-layered themes that have emerged from our analysis of a four-minute segment from our video data.

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Overview of project:

In 1998, a designer of educational software introduced a rocket simulation into a middle school science project. The designer took the role of teacher for the three-hour project and guided five students through an experimental exploration of rocket design. A video recording was made of the entire session. An interdisciplinary team is now analyzing the videotaped interactions in order to gain insight into the collaborative learning process in which the students and teacher co-constructed the meaning of the computer simulation. A four-minute video clip extracted from that video recording (Tape A 0:23:25-0:27:59) will be presented as an exemplar of the kinds of observable features of the conversation, vocalizations, gestures, and other behaviors captured in this recording as induced by microethnographic analysis.

In the course of the project, the 7th grade students "launched" one hundred simulated rockets, with eight different configurations of rocket design features, and recorded the heights they reached. Working with the teacher/designer, they collaboratively conducted analyses of their data and made scientific predictions of rocket performance as influenced by design features. During the segment under scrutiny, they learned how to "launch" the rocket and record on data sheets maximum heights reached. In so doing, they and the teacher/designer co-constructed a meaning for the simulation as an artifact that is not only engaging but can be used as an aid in their larger model rocket project. During the course of the entire session, the participants formulated an experimental procedure; collected, organized, and summarized data; analyzed the effects of various rocket characteristics; discussed their findings; predicted behavior of another rocket; and debugged problems they encountered.

Research methods:

The teacher/designer videotaped his two-session interaction with the student users of his simulation software program. Microethnographic video analysis (Heath, 1986; Streeck, 1983) provides a unique window into the very subtle and complex social and cognitive processes that promote the collaborative learning that can take place when a computer-based artifact is introduced into a classroom. The method used is primarily collective interaction analysis (Jordan & Henderson, 1995) by an interdisciplinary group of people, including participants trained in communication, linguistics, ethnography, education, computer science, and cognitive science. To support the interpretation, the entire tape has been logged and key segments digitized and transcribed. Close attention is paid to gaze, gesture, bodily positioning, noise-making, mugging, and overlapping of turns, in addition to speech. These factors are interpreted together in group sessions to resolve ambiguities. The teacher/designer's participant observation also informs the analysis, providing insight into the broader classroom context and details of the simulation or the classroom interactions that are not clear in the video. The research group is currently collaboratively reviewing several dozen theoretical texts (listed at http://www.cs.colorado.edu/~gerry/readings/simrocket/bibliography.html) that provide a broad range of perspectives on the role of cognitive artifacts. These theoretical frameworks suggest things to look for in the video data and possible interpretations of events and patterns that are observed in the data. However, the data is clearly seen to be richer and more reliable than any of the theories, and the data always grounds the interpretation.

Preliminary results:

While our analysis is now too preliminary to allow us to explore ultimate implications, we have already been able to identify a number of themes that have begun to emerge from analysis of the video. In the event captured in the video, a group of five boys engaged in a scientific activity with mixed success. On their own, as individuals or as a group, they could not have used the computer simulation artifact as a tool for scientific experimentation. In contrast, an adult could accomplish this individually. Within the group context and under the guidance of the teacher/designer, however, the students could engage in this activity and develop an understanding of the artifacts and procedures as meaningful.

The following themes seem to be emerging from our engagement with the video record:

1. *Episodic experience* (Donald, 1991). The students experience each rocket launch as an engaging activity and they focus on its many unique features as a concrete event.
2. *Mimetic experience* (Donald, 1991). The students experience the rocket viscerally. They engage in physical activity – especially by creating rocket-like vocalizations – through which they bodily identify with the rocket launch as though with a real-world event.

3. *Transparency* (Ehn, 1988). The students "see through" the technology to experience the rocket itself in its virtual world. Of course, they are also aware of the technology and focus on it at other times.
4. *Affordances* (Keil-Slawik, 1992). The students are keenly aware of what can and cannot be simulated in the software; the group activity explores this and reflects on the proper use of the artifact.
5. *Interpretive levels*. The students are facile at moving between levels of reality, experiencing in turn: the rocket, imaginative projections of rockets, the computer technology, and alternative software designs.
6. *Perspectives* (Stahl, 1999). Each student (as well as the teacher/designer) observably has his own way of participating in the group process.
7. *Bodily arrangements* (Kendon, 1990; Streeck, 1993). The five students form two groups in front of two computers, with periodic inter-group interactions. The teacher generally moves behind them, but occasionally appears between the computer and the students, or causes one or more students to orient toward him.
8. *Gestures* (Streeck, 1996). Gestures are used primarily to direct group attention toward something in the simulation or on a data sheet, but also to point to the technology, such as a mouse or software icon, or to orient someone to a task.
9. *Sound effects and exclamations.* Vocalizations dominate this particular video clip. They may be attempts to initiate communication that may or may not be picked up by others. They may be forms of egocentric self-talk (Vygotsky, 1930/1978): utterances of emotional reaction to experiences, which other individuals might have internalized as silent thoughts.
10. *Kids' culture* (Garfinkel et al., n. d.; Goode, 1994). The students engage in a style of interaction that is independent of the school classroom culture, and at times perhaps subversive of it.
11. *Zone of proximal development* (Vygotsky, 1930/1978). The students each have different abilities or styles for learning within the group – but these are not simply individual psychological developmental levels, but differences in how they learn in the presence of an adult or a group of peers.
12. *Situatedness within the activity context* (Engeström, 1999). The science project involves computing effects of different rocket characteristics and firing physical model rockets; these activity goals influence the understanding of the simulation artifact.
13. *Modeling scientific thinking.* The teacher's statements frequently model systematic, step-wise structures of analytic thinking and precision in expressing observations; students often pick up on this and incorporate it into their statements, even reformulating the statements of other students in this way.
14. *Data collection and analysis skills.* The data sheet for recording rocket heights forms an important external memory artifact (Norman, 1993) that is also introduced in this video clip. The group begins to construct its meaning here. Later, its use will become confused and the teacher will model systematic, reflective use of this artifact.
15. *Isolated tasks.* Some students can be seen to be highly oriented toward performing isolated, teacher-assigned tasks, like launching a rocket or averaging several numbers on a calculator (an artifact already understood by the students). Other students are more interested in the larger experimental questions of the activity.
16. *Division of labor and coordination.* Tasks such as firing rockets, observing heights, recording heights, averaging heights, and drawing conclusions from the averages are divided among the students through their social interactions. The coordination of results is often problematic.

Relevance to education:

We are interested in understanding collaborative learning in science classrooms and in how to support such learning with computers. We focus our analysis of classroom interaction on the use of physical and computer-based artifacts because:

1. We have observed that collaborative interactions often center around and make use of artifacts.
2. Learning – including school learning of scientific and mathematical activities – is made visible (by the participants for each other, and therefore also observable to researchers) through interactions with artifacts and their deployment as both media for learning and expressions of learning outcomes.
3. We want to develop methods for incrementally improving the design of computer support for collaborative learning by analyzing the ways in which artifacts are or are not successfully taken up as resources for collaboration and learning in naturalistic settings.

We believe that we have started to analyze a variety of aspects of the video that can contribute to a rich and empirically informed understanding of the collaborative learning taking place around a computer-based artifact, whose role in students' learning is of special interest. As we see these themes being played out in the video clip, we anticipate gaining access to a number of aspects of collaborative learning that are normally invisible and therefore difficult to identify and document without the kind of methodology we are trying to develop.

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