Narrative Example of modeling discourse: The ball bounce

This section follows a modeling activity from introduction to conclusion. This particular activity was chosen because it has been video taped and viewed by many people in physics education. Included with this dissertation is a Quicktime™ movie on CD-ROM of this activity that was created by Mangela Joshua and used here with permission of the developer (M. Joshua, personal communication, December, 2001). The activity was one class period long. Homework related to the activity was given and discussed during the next class. However, this narrative will only include the one class period.

Prior to this activity students had developed and deployed particle models of objects undergoing constant acceleration. Causes of motion had not been discussed – only descriptions of motion. Representational tools developed to this point included only graphs and motion diagrams. This activity is the first of the semester where students are confronted with a situation in which their existing models fail.

The activity began with a brief introduction by the instructor. The instructor showed the ball that would be used and demonstrated how to drop the ball. The instructor also instructed the students to hold the motion detector above the ball. Having described what motion the class would investigate the instructor moved on to explain expectations for the activity. The students were asked to first predict what graphs of position, velocity, and acceleration would look like for the ball. Students were allowed to drop the ball to help in making their predictions but were instructed not to take any data. Students were told to put their predictions on a white board and show them to the instructor before taking data. After showing the instructor the predictions the students

were to take data and get a data set that contained at least three bounces. Students were to then compare their predictions to the actual data. Students were told to compare and contrast the data and their predictions. Lastly, the students were told to identify places in the data where the models they developed would not be appropriate. The instructor ended the instructions by stating that after all groups completed white boards a whole class discussion would occur.

The groups of students began by getting a ball and all the equipment needed for taking data. The equipment included a ball, a computer, a motion detector, and a computer lab interface. After setting up the computer the students began to make their predictions. While the students were making their predictions the instructor moved around the classroom looking at the predictions without making any comments. Groups of students started to call the instructor over to get their predictions approved so they could begin to take data. The first group was told to redo their predictions based on the fact that the motion detector was above the ball. That was the only hint given before the instructor moved on to the next group. The instructor asked the next group to identify events on the different graphs that occurred at the same time. The remaining four groups were told to make the same clarification. The instructor never commented on the actual predictions but only clarified times and location of the motion detector. Shortly thereafter, all groups' predictions were approved and students began to take data.

The instructor kept a low profile sitting at the front of the class observing while students began taking data. Students quickly realized that taking data required the group to work together. A few minutes after students began taking data the instructor started to move among the groups offering small pieces of advice on taking data. For example, the

instructor pointed out objects that might interfere with the motion detector. After a few practical pieces of advice all groups began to collect data. Several groups focused on getting more bounces while others focused on getting as big of bounces as possible. Soon, all groups had data they were satisfied with and began to sketch their data on top of their predictions.

At this point the instructor began to seed the major ideas for this activity to the students. The instructor seeded three major ideas. Each idea was seeded to two groups in slightly different manners. Two groups were seeded with the question: why does the ball not bounce as high each time? Another two groups were shown that the ball was still moving downward even after making contact with the floor. The last two groups were told to focus on the data that looked like the data from previous experiments.

The seeding was done in a similar manner to the following for all groups. The initial idea or question was given to the students and then the instructor left the group. The students were left alone to struggle with the question or idea. All groups had difficulty deciding what the question or idea meant and how to use the information supplied by the instructor. However, after a brief period of frustration each group started to use the information or develop other questions for the instructor. The resulting interactions for each seeded idea will be discussed below.

The groups seeded with focusing on the data that looked familiar progressed the quickest. The students quickly identified the parts of the data that behaved like previous experiments. These results were quickly added to the predictions on the white board. However, the students brought back the instructor to ask a follow up question. The students wanted to know what to do with the portions of the graphs that did not look like

previous experiments. The instructor suggested that the students try to idealize those portions of the graphs. The two groups used this information to develop similar conclusions. These students modeled the collision with the ground as occurring instantaneously and made graphs appropriate to this model.

These two groups were seeded this information for different reasons. One group was chosen because they tended to be quiet during a whole class discussion. By having a simplified model they were an appropriate group to go first during the all class discussion. The other group did not easily accept new ideas and would get actively involved in a discussion even if they never presented their white board. Therefore, they were chosen not to be presenters but questioners of the other groups new and unique ideas.

The two groups seeded with the idea that the ball was still moving downward even after contacting the floor quickly realized that the particle model of objects would not be appropriate. Both groups asked a similar follow-up question of the instructor – how do we model the ball? The instructor guided each group in developing a model that was simple, yet would behave similar to the data. After developing a model of the ball the instructor left, suggesting that the groups now decide what might be an appropriate model for the floor. The white boards from these groups focused less on the data and more on the models of the ball and floor. One group went further and focused on when each model needed to be used based on the data collected.

These two groups were chosen for this seeding because several of the students in the groups were very creative. They liked challenges and looking at more complex situations. However, these groups could also easily go astray and thus were given very

specific objects and models to focus on. The instructor hoped one of these groups would present their ideas after the initial group went.

The last two groups were seeded the most complex idea. They were seeded the question of why does the ball not bounce as high each time? They were chosen because these groups tended to work faster than the other groups and needed a challenge to ensure they finished about the same time as the other groups. One of these two groups was good at making clear, understandable white boards. The other group was very good at explaining ideas and synthesizing ideas from several groups.

After being asked the initial seeded question by the instructor, both of these groups began brainstorming for ideas. The instructor left the groups so that this brainstorming could occur. Soon both groups were out of ideas and asked the instructor for a little more guidance. The instructor asked each group about what ideas they had considered. In both cases the idea of energy loss had been discussed. The instructor built on that idea and other ideas the students had about energy. The students all stated a belief that energy was conserved and something moving had energy. The instructor introduced to the groups a new tool, the energy pie chart. The groups were shown how to use the tool and told to incorporate it into their white boards. Both groups quickly synthesized the ideas into their own and developed appropriate white boards.

During this period of small group work the instructor went from group to group seeding ideas and answering questions, normally with one or more questions. The whole activity to this point had taken about one hour and fifteen minutes. The whole class was now ready for discussion. The instructor circled the class and picked a group to present

their ideas first. The group picked was one of the groups seeded with the idea of ignoring the data the existing models did not explain.

The discussion was lively, friendly and engaging. Only one group was asked to present their ideas but all groups contributed something from their white boards. Nearly every student made at least one comment and those that made no comments were actively following the discussion. During the discussion the instructor only intervened for the following two reasons: to ensure only one person talked at a time and to remind students that terminology must be agreed upon before being used in discussion. The discussion lasted for an hour and fifteen minutes.

During the discussion the students presented all of the seeded ideas. Agreement was reached on many ideas. First the students came to consensus on when the models developed before this class period were appropriate to use. Second they agreed that their existing models were insufficient to explain the data. They agreed upon new models that helped explain the data. Even though the instructor seeded many of these ideas the students presented them as their own and explained them in their own words and not the instructor's. The students worked towards consensus without being competitive.

While the discussion was occurring the instructor sat behind the class with a white board. The instructor took notes on the white board. These notes included ideas to be clarified, terms to be agreed upon, and questions to ask the class. As items were clarified by the discussion the instructor removed these items from the white board. Not all items of clarification were removed from the white board by the end of the discussion. At the end of the discussion the instructor recapped what the students had agreed upon. The instructor did not address the issues for clarification on his white board. Those items

were left for another class. The class ended with the instructor handing out homework using the new tool of energy pie charts. The students put away their equipment and left for the day. The total class time was two hours and forty minutes.

Conclusions

This narrative was not meant to be a complete description of the ball bounce activity. It does, however, show a typical modeling activity from beginning to end. The narrative also shows how several of the major components of modeling discourse management are used in the classroom. Other components, such as development of a learning community, were only implied. The modeling discourse class used this pattern for activities. The activities were not always lab based but the management of the classroom was always the same.

Modeling discourse management is a work in progress. The formative evaluation is not only used to guide the classroom activities but also to improve modeling discourse management. The work of development continues and new activities are continually being tried and evaluated. An outline of activities for the 1998-1999 CGCC class is located in **Appendix E**. Other modeling discourse classes used in this study used nearly the same activities.